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GJB

Euastacus suttoni Clark

Cover: The Queensland freshwater crayfish, *Euastacus suttoni* was originally described by Ellen Clark of the National Museum of Victoria in 1941. This plate was published in the *Memoirs* in that year. The species is redescribed by Gary Morgan and compared with other species from Queensland in this issue.

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CONTENTS

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FRESHWATER CRAYFISH OF THE GENUS *EUASTACUS* CLARK (DECAPODA: PARASTACIDAE) FROM QUEENSLAND

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Abstract

Morgan, G.J., 1988. Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from Queensland. *Memoirs of the Museum of Victoria* 49: 1-49.

Twelve species of *Euastacus* from Queensland, including three new species, *E. balanensis, E. eungella* and *E. jagara,* are described or redescribed, employing external characters, measurement ratios and gastric mill characters. The genus *Euastacoides* Riek is synonymised with *Euastacus.* A key to the Queensland species of *Euastacus* is included.

Contents

Introduction

The species of the Australian freshwater crayfish genus *Euastacus* occurring in Victoria have been reviewed by Morgan (1986) in the first of a series of papers. This second contribution examines species found exclusively in Queensland or with type localities in that state.

The methods and abbreviations employed in this study are those described by Morgan (1986). Additionally, the Queensland Museum, Brisbane, is abbreviated as QM. Scales in figures 3-25 are in mm.

The eastern area of Queensland was sampled extensively for this study in 1981, with particular emphasis upon high country of the Great Dividing Range. Distributions of species are illustrated in Figures 1 and 2.

Euastacus balanensis sp. nov.

Figures 3, 4

Material examined. Holotype. Qld, tributary of Davies Ck, Lamb Range, Atherton Tableland, (17°03′S, 145°37′E), 2 Jul 1981, G.J. Morgan and S.J. Harders, QM W10984, ♂, OCL 33.0 mm.

Paratypes. Qld. Type locality, QM W10985, 1♀; Tributary of Kauri Ck, north of Tinaroo Falls Dam, Atherton Tableland, (17°06′S, 145°35′E), 1 Jul 1981, G.J. Morgan and S.J. Harders, QM W10987, 2♂; Maguba Ck, Mt Bartle Frere, Bellenden Ker Range (17°26′S, 145°50′E), 18 Jul 1981, G.J. Morgan and S.J. Harders, QM W10986, 1♂, 1♀.

Diagnosis. Male cuticle partition present. Rostral marginal spines apical or distributed to midlength of carinae. Rostral base very divergent, carinae spread. Antennal squame widest at or slightly proximal to midlength. Squamal spines absent. Suborbital spine usually medium-sized. Thoracic spines weakly developed. General tubercles small, moderately to densely distributed. 3-8 medium-sized or small Li spines on abdominal somite 2. D abdominal spines and abdominal boss absent. Tailfan spines absent. Lateral propodal spines usually in 2 to 1 row condition, ventral row poorly developed (occasionally absent). 0-2 dorsal apical propodal

Key to Queensland species of *Euastacus* (specimens >20 mm OCL)

1. Carpus of cheliped with deep longitudinal groove in dorsal surface; at least 1, usually several, mesal dactylar spines 2
— Carpus of cheliped with very shallow longitudinal groove in dorsal surface; mesal dactylar spines absent 11

2(1). Thoracic and telsonic spines medium-sized to large, or if thoracic or telsonic spines small or absent: lateral propodal spines in 2 to 1 row condition, rostral carinae of medium length to long, suborbital spine large to very large; usually 2 mesal carpal spines, or if 3: usually large thoracic or D-L abdominal spines. [Species can grow very large, with large and sharp Li and D-L abdominal spines] 3
— Thoracic spines absent or just discernible (rarely few small dorsal spines behind cervical groove) and above character combination not applicable; 3 or more mesal carpal spines. [Small species with poor abdominal spination] 6

3(2). Mesal dactylar basal spines absent ..... *E. valentulus*
— 1 or more dorsal mesal dactylar basal spines and sometimes marginal mesal basal spines 4

4(3). Dorsal thoracic spines absent (sometimes just discernible); telsonic spines small or absent; usually 2-10 dorsal apical propodal spines; TAP ≤ 5 ..... *E. sulcatus*
— Dorsal thoracic spines medium-sized or large; telsonic spines usually medium-sized or large (sometimes small); usually 0 or 1 dorsal apical propodal spine, or if more than 1: telsonic spines large; TAP ≥ 5 5

5(4). Telsonic spines small or medium-sized; D abdominal spine present and usually sharp on somites 2-4; red spines on abdomen and thorax; 0 (rarely 1) lateral spine on outer ramus of uropod ..... *E. suttoni*
— Telsonic spines usually large; D abdominal spine absent on somites 2-4 (dorsal boss present) or rarely very blunt D spine; overall colour dark green, including spines; 3-6 lateral spines on outer ramus of uropod [Usually 2 distinct spines per side on epistome] ..... *E. hystricosus*

6(2). Row of spines above propodal and dactylar cutting edges reaching proximal to midlength of chela gape or to full gape; ventrolateral propodal spine row well developed ..... *E. eungella*
— Spines above propodal and dactylar cutting edges absent or not distributed proximal to midlength of chela gape; ventrolateral propodal spine row absent or poorly developed (usually fewer than 4 spines if present) 7

7(6). Li abdominal spines small or medium-sized on somite 2, or if merely bumps: keel Pr3 parallel and 1 apical mesal dactylar spine 8
— Li abdominal spines reduced to low bumps and above combination of characters not applicable 10

8(7). Dorsal apical propodal spines absent; antennal squame widest very proximal to midlength; keel Pr3 parallel ..... *E. urospinosus*
— 1-2 dorsal apical propodal spines, or if absent: antennal squame widest at midlength or only slightly proximal to midlength; keel Pr3 not parallel 9

9(8). Rostral spines distributed along full length of carinae; keel Pr1 close; suborbital spine small ..... *E. maidae*
— Rostral spines apical or distributed to midlength of carinae (rarely slightly proximal to midlength); keel Pr1 apart or very apart; suborbital spine medium-sized or medium-large ..... *E. balanensis*

10(7). Suborbital spine medium-large to very large; 2 apical mesal dactylar spines; antennal squame widest very proximal to midlength ..... *E.setosus*

— Suborbital spine small or very small; 1 apical mesal dactylar spine; antennal squame widest slightly proximal to midlength ..... *E.jagara*

11(1). Ventrolateral propodal spine row poorly developed and central; usually 4-5 mesal propodal spines; keel Pr 3 and 4 usually narrow; TAP count 8.0-9.5. [Rostrum U-shaped on large specimens] ..... *E. fleckeri*

— Ventrolateral propodal spine row reaching to apex; 6-9 mesal propodal spines; keel Pr3 and 4 broad or very broad; TAP count 4.5-5.0 (Rostrum usually triangular) ..... *E. robertsi*

spines. Spines absent above propodal cutting edge. 5 mesal propodal spines. 1 apical spine above dactylar cutting edge. Dorsal and marginal mesal dactylar basal spines absent. 1 apical mesal dactylar spine. Carpal dorsolongitudinal groove deep. 3-4 mesal carpal spines. Largest ventromesal carpal spine usually subequal in size to ventral spine. Keel Pr1 sloped to semi-abrupt and apart or very apart. TAP count 3.5.

Description Maximum OCL: 33.0 mm.

Rostrum: Short, not or just reaching base of antennal segment 3 on specimens >30 OCL, to or slightly distal to base of segment on specimens 20-30 OCL. Rostral sides parallel, rarely slightly convergent; base very divergent and spread. Rostral marginal spines numbering 2-3 per side, and either apical or reaching midlength of carinae; spines medium-sized to small or moderately pointed or rounded. Acumen spine similar to marginals.

OCL/CL 0.85-0.88 i. RW/OCL 0.14-0.17 d.

Cephalon: Spination moderate or weak with several small spines below postorbital ridges. 1st postorbital spine small, 2nd postorbital spine absent. Suborbital spine usually medium-sized, large on some specimens >30 OCL. Lateral margin of squame straight or slightly concave; squame widest at or slightly proximal to midlength; marginal spines absent. Interantennal spine elongate with margins smooth to serrated, and slightly toothed on one specimen; ventromedial surface sometimes bearing small spine. Antennal basipodite spine small or absent; coxopodite spine small or absent, sometimes weakly bifid or serrated.

ScL/OCL 0.14-0.17 d.

Thorax: Dorsal thoracic spines very weakly developed; specimens >30 OCL usually with 1-2 small, blunt spines behind cervical spines. General tubercles small, moderately to densely distributed. Cervical spines numbering 3-6, medium-sized to small (usually similarly sized) and moderately pointed to blunt.

ArL/OCL 0.38-0.40. CaW/OCL 0.53-0.56. ArW/OCL 0.16-0.20 d. CaD/OCL 0.43-0.47 d.

Abdomen: Somite 1 lacking spines. Somite 2 of specimens >30 OCL with 3-8 Li spines per side, frequently 1 or 2 obviously larger than other usually tiny, rather blunt spines. Anterior Li spines small to medium-sized and moderate to sharp. Tiny Li spine on somites 3-5. Of two specimens <30 OCL, one with 3 small Li spines on somite 2, other lacking spines; subsequent somites lacking spines. 1 or 2 tiny, blunt Lii spines sometimes on somites 3-5 of large crayfish. Somite 6 sometimes with 1-3 tiny Lii spines. D-L and D spines and dorsal boss absent.

AbdW/OCL ♂ 0.45-0.51, ♀ 0.52-0.54. OCL/L 0.41-0.43 i.

Tailfan: Tailfan spines absent though setal bumps obvious on margins of telson and uropods. Standard spines small, medium-sized on one specimen <30 OCL.

TeL/OCL ♂ 0.31-0.37 d, ♀ 0.34-0.35.

Chelae: Chelae elongate on specimens >30 OCL, intermediate in shape on smaller crayfish. Lateral propodal edge often concave. Teeth moderately to well developed on specimens >30 OCL.

Propodus: Lateral propodal spines usually in 2 to 1 row condition, ventral row poorly developed, often merely 2-3 midlateral spines; one large specimen lacking ventral row. Lateral spines small to medium-sized and rather sharp. Lateral spine ridge absent. 5 mesal propodal spines (one specimen with 6 on apparently regenerate chelae). 0-2 dorsal apical propodal spines. No spines above cutting edge of propodus (one specimen with 2 small apical spines on regenerate chelae). Dorsal spines lateral to dactylar base usually absent (one specimen with small spine on its smaller chela); very slight lateral bumps present. Ventrally, 1-2 small spines lateral to dactylar base. No spines proximal to dactylar articulation. 0-2 small precarpal spines.

PropL/OCL 0.87-0.98 i. PropW/PropL 0.43-0.47. PropD/PropL 0.27-0.31.

Dactylus: 1 spine above cutting edge of dactylus (one specimen <30 OCL lacking spine; one specimen with 3 spines on regenerate chelae); spine apical and large to small. Extra dorsal dactylar spines absent. Basal mesal dactylar spines absent. 1 apical mesal dactylar spine. Dactylar groove deep.

DactL/PropL 0.57-0.59.

Carpus: Dorsolongitudinal groove deep. 3-4 mesal carpal spines; distalmost largest and offset ventrally to others. Usually 2 (occasionally 1) medium-sized to tiny lateral spines. Articulation spine small or absent. Dorsal carpal spines absent. Ventral spine medium/large or medium-sized; 3-5 ventromesal spines, largest usually subequal in size to ventral spine.

Merus: 5-10 small dorsal meral spines. Outer spine small.

Keel: Pr1: Posterior margin sloped to semi-abrupt; ventral edge usually angled back (angled down on one speci-

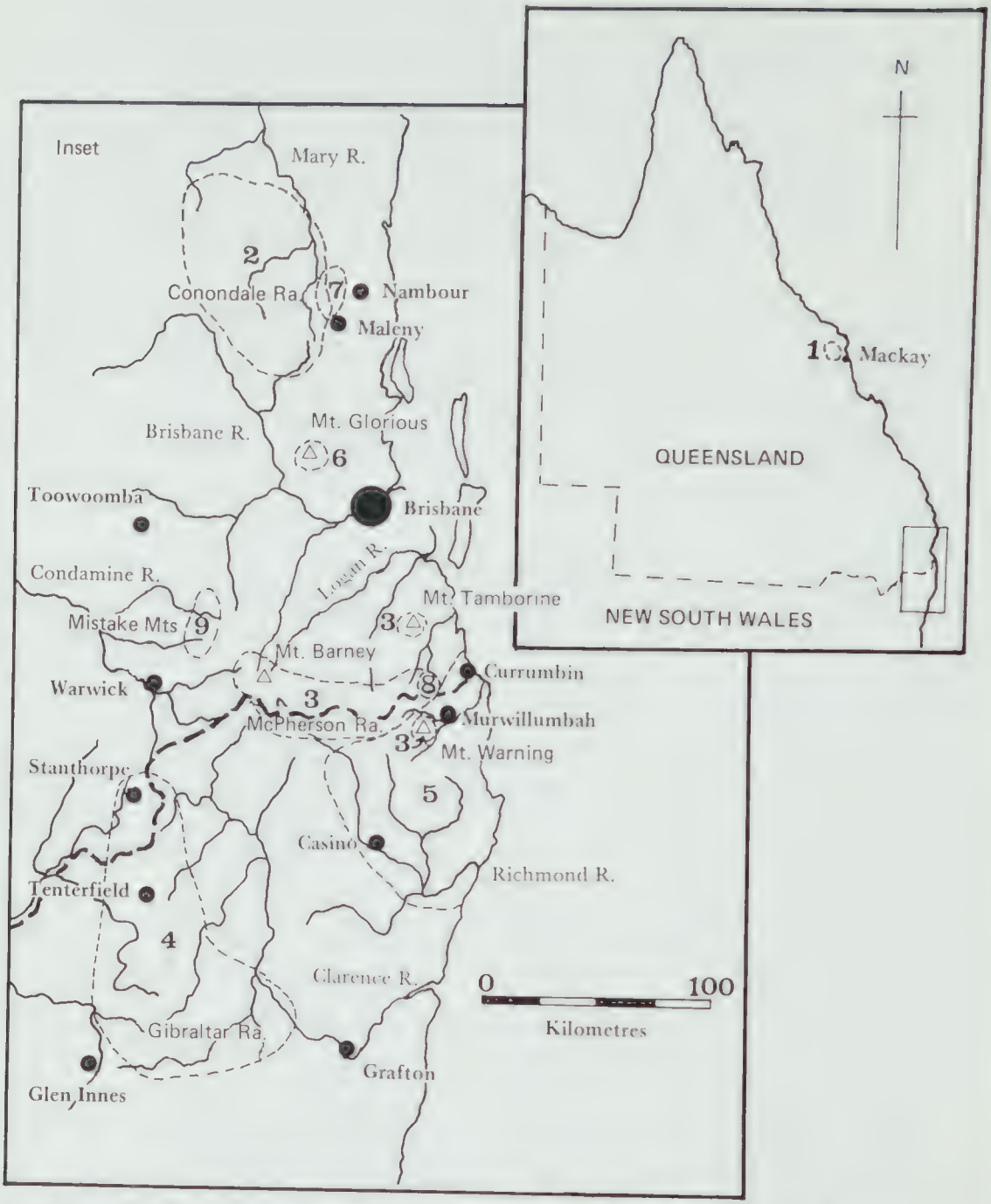

Figure 1. Distribution of *Euastacus* species in Queensland – 1, *E. eungella*; 2, *E. hystricosus*; 3, *E. sulcatus*; 4, *E. suttoni*; 5, *E. valentulus*; 6, *E. setosus*; 7, *E. urospinosus*; 8, *E. maidae*; 9, *E. jagara*.

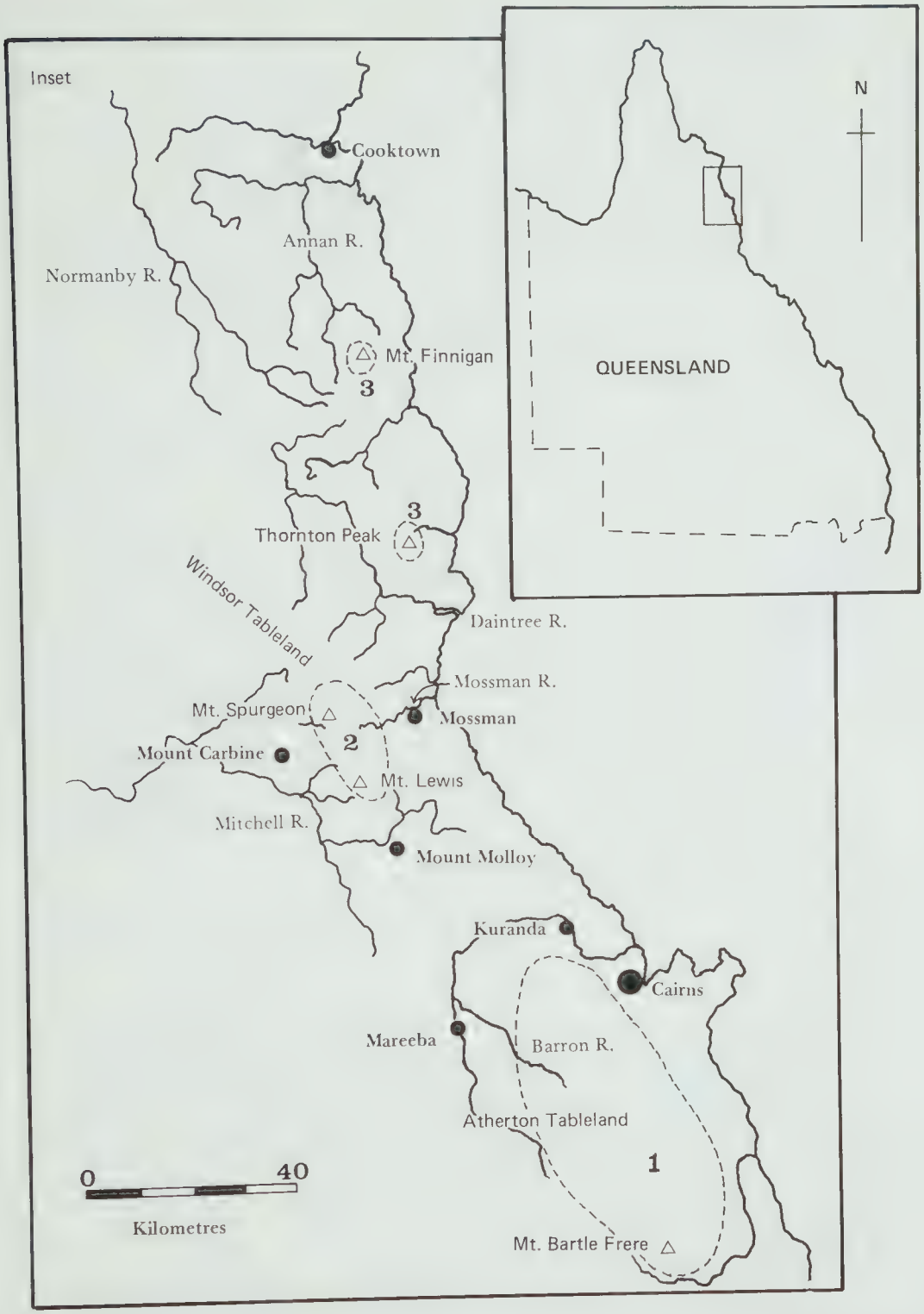

Figure 2. Distribution of *Euastacus* species in Queensland—1, *E. balanensis*; 2, *E. fleckeri*; 3, *E. robertsi*.

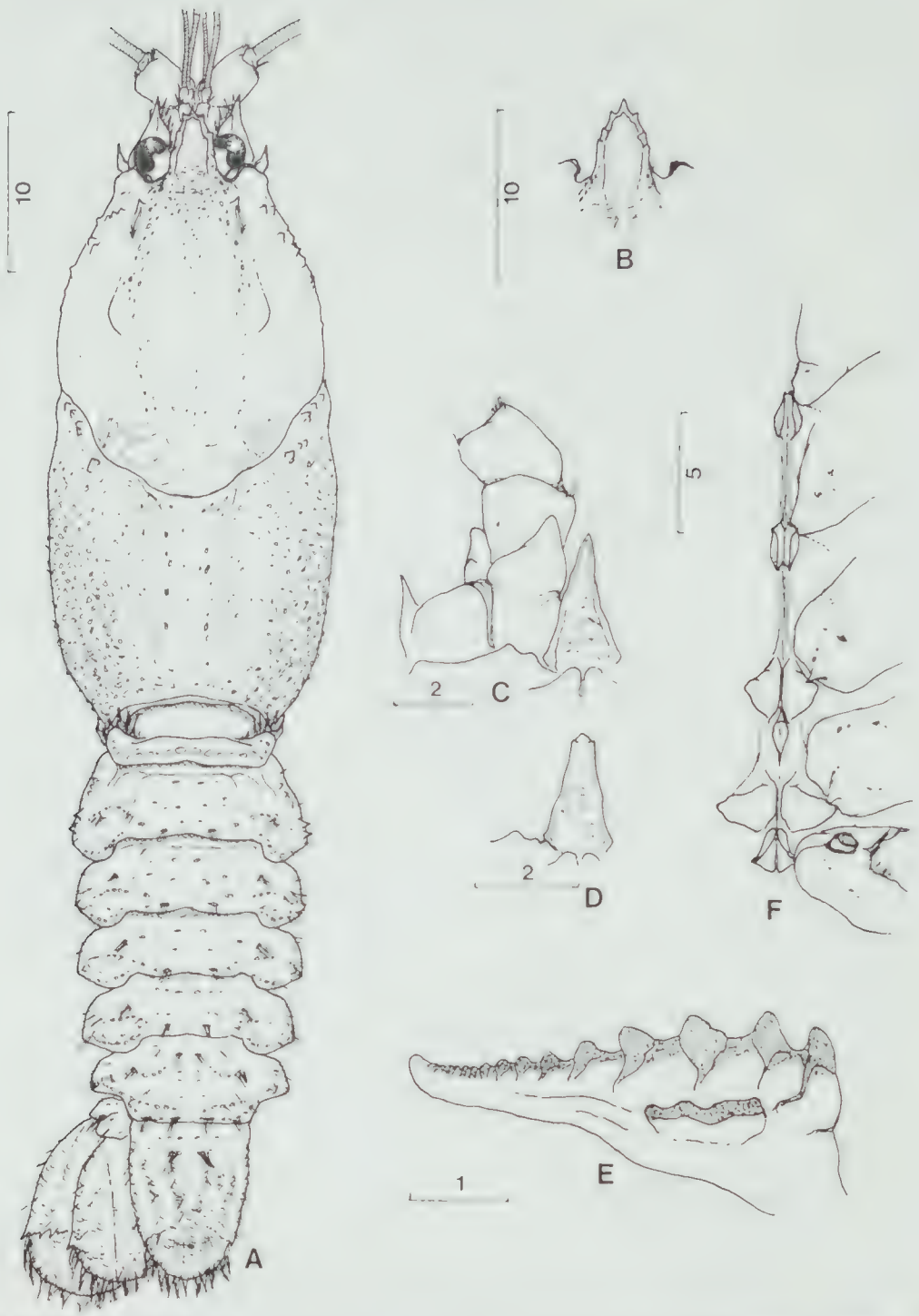

Figure 3. *Euastacus balanensis*. A, dorsal view (holotype ♂, Davies Ck, QM W10984); B, rostrum: broader, more spinose (paratype ♂, Kauri Ck, QM W10987); C, ventral view cephalon (holotype ♂); D, interantennal spine (paratype ♂, Kauri Ck); E, zygocardiac ossicle (paratype ♀, Maguba Ck, QM W10986); F, sternal keel (holotype ♂).

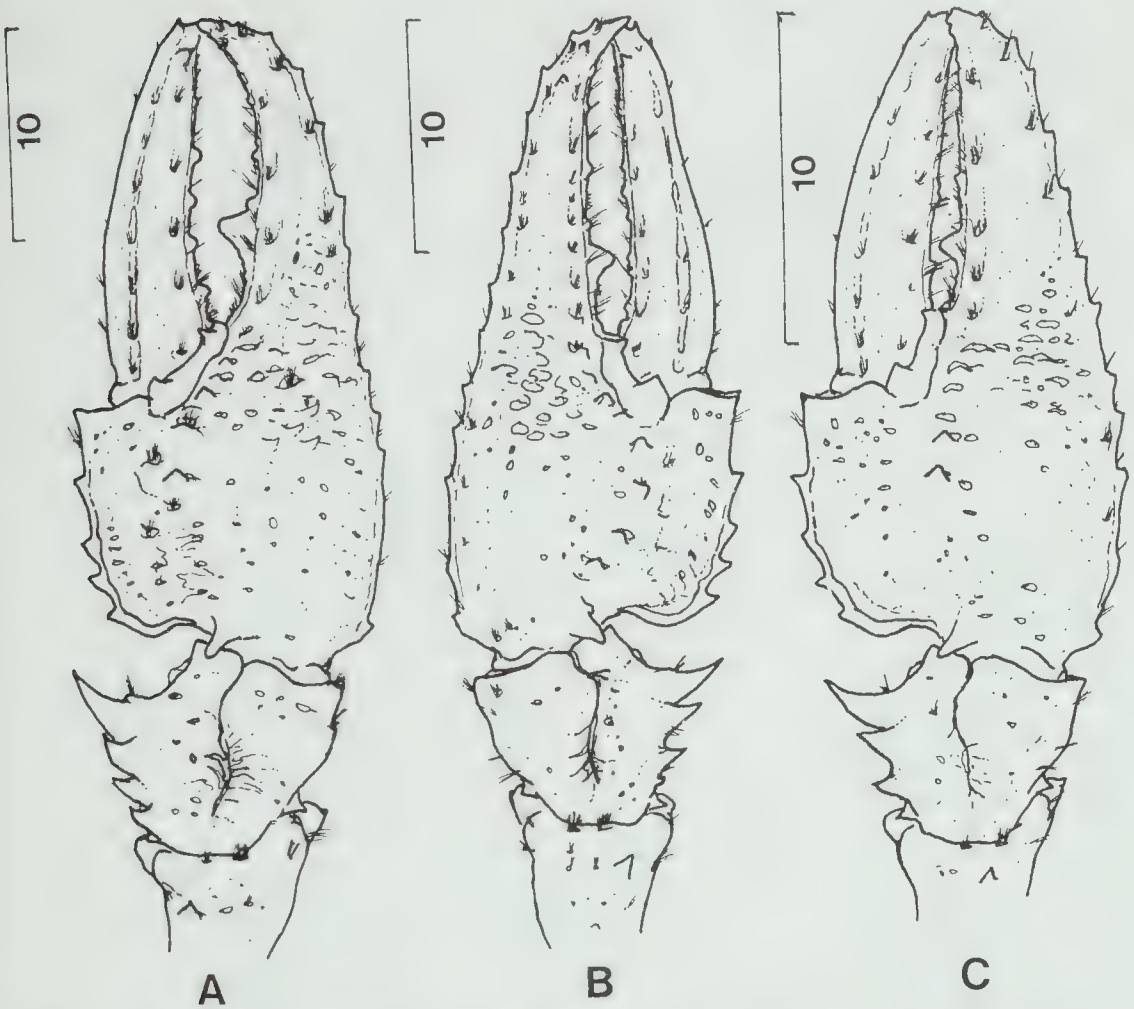

Figure 4. *Euastacus balanensis*. A, dorsal view chela (holotype ♂); B, chela: more elongate, 2 apical dorsal propodal spines, 4th mesal carpal spine small (paratype ♀, Davies Ck, QM W10985); C, chela: stouter, 3 mesal carpal spines (paratype ♂, Maguba Ck, QM W10986).

men); processes apart or very apart and closed in orientation. Keel after Pr1 sometimes with low spine.

Pr2: Open or parallel, and very apart. Keel after Pr2 slightly pronounced anteriorly.

Pr3: Lateral profile moderately rounded or sharp, lacking or with very gradual scoops. Keel after Pr3 pronounced anteriorly.

Pr4: Posterior edge moderate to sharp and straight, slightly convex or irregular. Scoops absent. Anterior margins angular or very angular.

Processes 3 and 4 broad with sharp narrow keel.

Setation: Moderate to rather heavy. Bartle Frere crayfish more setose than those from Atherton Tableland.

Punctation: Moderate to dense on cephalon, dense or very dense on thorax.

Gastric mill: TAP count 3.5; TAA count 1.0-1.5; spread 2.0-2.5. Teeth large and spaced.

Urocardiac ridges 4-5 (rarely 6).

Coloration: Body dark green/brown or olive dorsally, paler brown ventrolaterally. Dorsal spines (if present) and cephalic spines pale orange. Rostral carinae dark green. Abdominal L spines brown or pale green. Carpus and propodus of cheliped green/brown, spines tipped with orange. Fingertips paler.

Body ventrally orange and green. Chelae green/orange, often blue patch at carpal/propodal articulation. Propodal and dactylar mesal edges dark green. Fingers orange, tips often yellow.

Very small specimens orange, pink or grey.

Sexes: Males possess a wide cuticle partition.

Two females were collected, both in the 30-40 OCL range. On one, the gonopores appear to be opening. The other is berried with open gonopores. Hence, females probably mature at lengths close to 30 OCL. Eggs are orange/brown.

Distribution and biology. The species has been collected in tropical rainforests at altitudes above 800 m a.s.l. on the Atherton Tableland, west of Cairns and from the Bellenden Ker Range west of Babinda. This is the highest country in Queensland. At lower altitudes, species of *Cherax, Macrobrachium* and *Atyoida* were common. No specimens of *Euastacus* were collected adjacent to human habitation. The berried female was obtained from a shallow burrow in July.

Etymology. Name derived from "balan" (fresh water) in Dyirbal, the major language of the Bellenden Ker area (Dixon, 1972).

Remarks. Only six specimens of this small species have been collected from a relatively small area of north Queensland and geographical variation cannot be interpreted.

Euastacus eungella sp. nov.

Figures 5, 6

Material examined. Holotype. Qld, tributary of Cattle Ck (North Branch), near Mt Dalrymple, Eungella National Park, west of Mackay, (21°02'S, 148°37'E), 13 Jun 1981, G.J. Morgan and S.J. Harders, QM W10980, ♂, OCL 33.0 mm.

Paratypes: Qld. Type locality, QM W10981, 1♂, 4♀; Creek 1 km along track from Crediton Camp, Eungella Nat. Park, (21°11'S, 148°31'E), 11 Jun 1981, G.J. Morgan and S.J. Harders, QM W10982, 3 juveniles; Cattle Ck (South Branch), Eungella Nat. Park, (21°08'S, 148°30'E), 12 Jun 1981, G.J. Morgan and S.J. Harders, QM W10983, 1♀; Clarke Range near Crediton, 17 Apr 1975, QM W4806, 3♂, 3♀, 1 chela.

Diagnosis. Similar to *E. balanensis,* except: rostral marginal spines not apical, distributed to, or proximal to midlength of carinae. Antennal squame widest at or slightly distal to midlength. 4-9 Li spines on abdominal somite 2. 2 lateral propodal spine rows, ventral row well developed. Usually 2-4 dorsal apical propodal spines. Spines above propodal and dactylar cutting edges distributed proximal to midlength of gape. 5-6 mesal propodal spines. 0-2 dorsal mesal dactylar basal spines. 1-3 apical mesal dactylar spines. Proximalmost (4th) mesal carpal spine absent or small. Ventromesal carpal spine smaller than ventral spine. Keel Pr1 close. TAP count 3.5-4.0.

Description. Maximum OCL: 33.0 mm.

Rostrum: Short, usually not reaching beyond base of 3rd antennal segment, occasionally slightly beyond on specimens <20 OCL. Rostral sides parallel or slightly convergent; carinal base short, spread and divergent or very divergent. 3-5 marginal spines per side, small or medium-sized and moderately pointed; spines distributed to midlength or proximal to midlength of carinae. Acumen spine similar to or slightly larger than marginal spines.

OCL/CL 0.81-0.86 i. RW/OCL 0.16-0.20.

Cephalon: Spination moderate or weak, with 1-3 small spines and bumps below postorbital ridges. First postorbital spine medium-sized or small. 2nd postorbital spine absent (one specimen <20 OCL with very small spine on one side only). Suborbital spine usually medium-sized, large on some specimens <30 OCL. Lateral margin of squame usually slightly concave; squame widest at or slightly distal to midlength; marginal spines absent. Interantennal spine elongate or of medium width on specimens >20 OCL, broad on some smaller animals; spine margins slightly or distinctly scalloped, ventromedial surface often with small blunt spine. Antennal basipodite spine small or absent; coxopodite spine very small and weakly bifid, or absent.

ScL/OCL 0.14-0.23 d.

Thorax: Dorsal spines very poorly developed or absent, just discernible on some large specimens, sometimes 1-2 small blunt spines posterior to cervical spines. General tubercles small to very small, dense or moderately dispersed on large specimens, sparse on some small animals; tubercles absent and branchiostegites merely punctate on most specimens <20 OCL. 2-5 cervical spines, medium-sized or small (tiny on some <20 OCL) and moderately pointed or blunt, though dorsalmost spine sometimes sharp.

ArL/OCL 0.34-0.39. ArW/OCL 0.15-0.22 d. CaW/OCL 0.49-0.55. CaD/OCL 0.46-0.51 d.

Abdomen: Somite 1 lacking spines. Somite 2 of specimens >20 OCL and some smaller animals with 4-9 Li spines per side, spines medium-sized to tiny and sharp to blunt; tiny Li spine usually on somites 3 and 4 of large specimens but vague or absent on somites 5 and 6. Specimens <20 OCL lacking spines or with 2-6 tiny Li spines on somite 2 and occasionally 1 spine on somite 3. Lii spines usually absent (one medium-sized specimen with tiny Lii spine on somite 5). D-L and D spines absent on all specimens. Dorsal boss absent.

AbdW/OCL (0.44)0.46-0.53 i. OCL/L 0.37-0.41 i.

Tailfan: Tailfan spines absent though setal bumps obvious on margins of telson and uropods. Standard spines medium-sized.

TeL/OCL 0.34-0.44 d.

Chelae: Chelae intermediate to elongate in shape. Teeth well developed on specimens >30 OCL.

Propodus: Usually 2 lateral propodal spine rows except on very small specimens with only dorsal row; ventral row usually commencing third to half propodal length from base, i.e. proximal half of propodus often with single row. Lateral spines small to medium-sized and rather sharp. Outer spine ridge weak or absent. 5-6 mesal propodal spines; 2-4 (rarely 1) dorsal apical propodal spines on specimens >20 OCL, frequently absent on smaller specimens. 4-6 spines above propodal cutting edge of

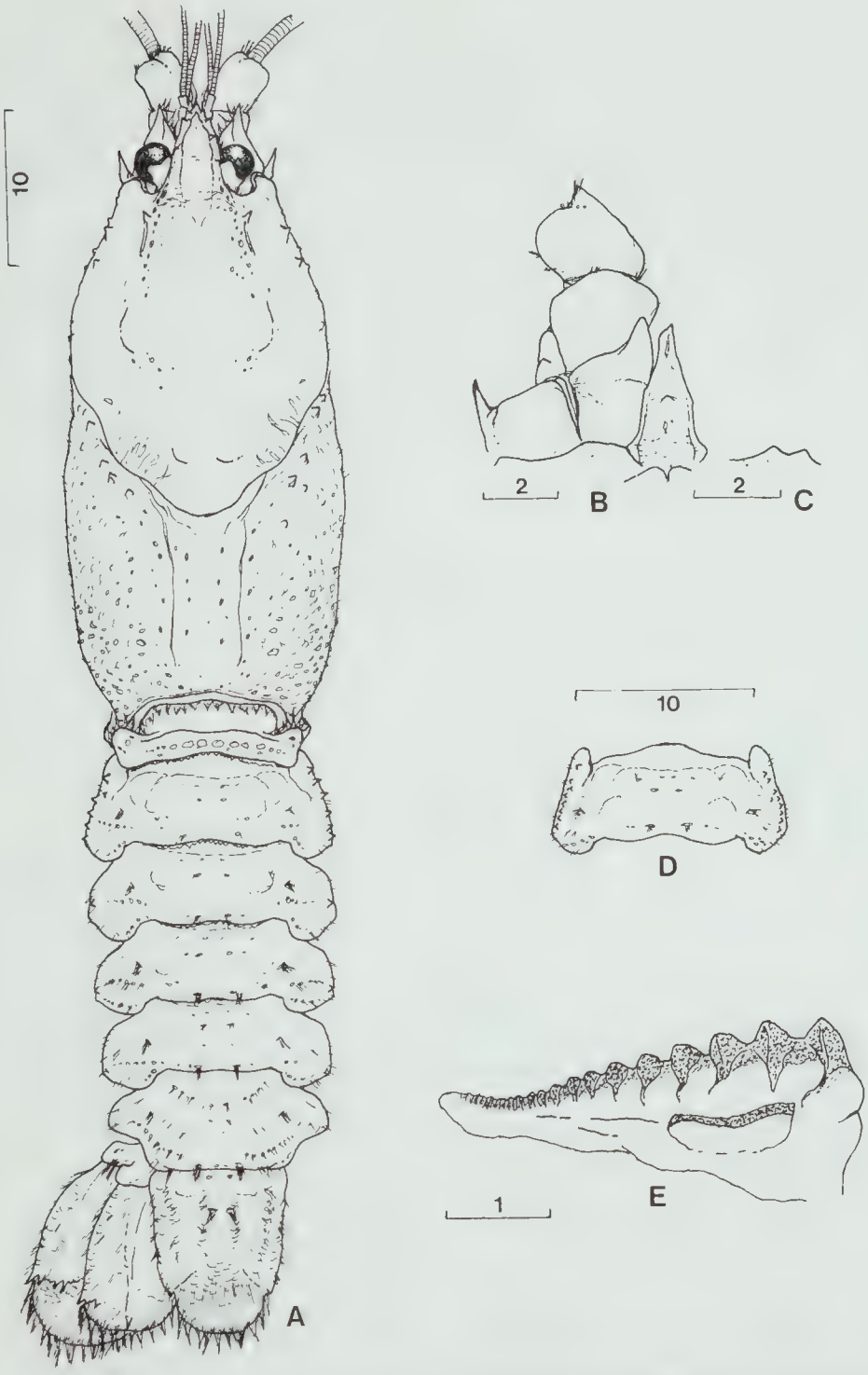

Figure 5. *Euastacus eungella*. A, dorsal view (holotype ♂, Cattle Ck, QM W10980); B, ventral view cephalon (holotype ♂); C, weakly bifid coxopodite spine (paratype ♂, Cattle Ck, QM W10981); D, abdominal somite 2: more numerous and smaller Li spines (paratype ♂); E, zygocardiac ossicle (holotype ♂).

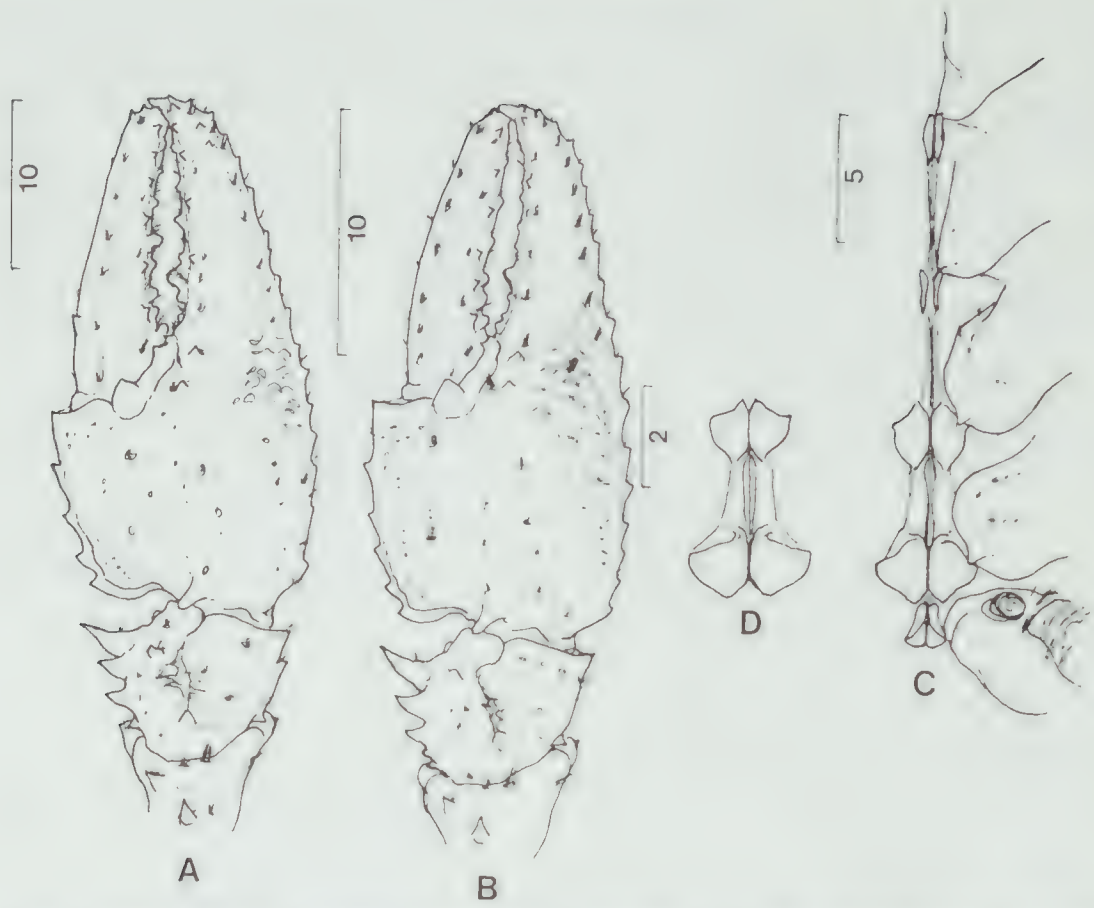

Figure 6. *Euastacus eungella*. A, dorsal view chela (holotype ♂); B, chela: 3 (+1) mesal carpal spines, 6 mesal propodal spines, mesal dactylar basal spines absent, 1 apical propodal spine (allometry)(paratype ♀, Cattle Ck, QM W10981); C, sternal keel (holotype ♂); D, keel Pr3 and 4: broader (allometry) (paratype ♀).

specimens >30 OCL, 1-5 on specimens 20-30 OCL; spine row usually reaching proximal to midlength or to full gape of chela, often reaching spines lateral to dactylar base dorsally, though apical or absent on specimens close to or slightly <20 OCL; spines large to small. Dorsally, 1-2 medium-sized or small spines lateral to dactylar base, with several small outer bumps or spines; ventrally, 1-2 medium or small spines. Spines absent proximal to dactylar articulation; precarpal spines absent except on some regenerate chelae.

PropL/OCL 0.92-1.02. PropW/PropL 0.41-0.48 id. PropD/PropL 0.25-0.30 id.

Dactylus: Row of 3-8 spines above dactylar cutting edge of specimens >20 OCL and 3-4 on smaller specimens, reaching proximal to midlength or to full gape; spines medium-sized or small, usually largest basally. Extra dorsal dactylar spines absent. 0-2 dorsal mesal basal spines, medium-sized and quite sharp. Marginal mesal basal spines absent. 1-3 apical mesal spines. Dactylar groove usually inconspicuous on large specimens, deep on some specimens <30 OCL.

DactL/PropL 0.48-0.59 i.

Carpus: Dorsolongitudinal groove deep. 3 or 3(+1) mesal carpal spines, distalmost largest and definitely offset ventrally. 2-3 outer carpal spines, small to medium-sized on specimens <30 OCL, sometimes large on larger specimens. Articulation spine tiny or absent, medium-sized on some specimens <20 OCL. Usually 1-2 small blunt dorsal carpal spines. Ventral spine large or medium/large (small on some very small individuals); ventromesal spines numbering 2-3, largest medium-sized or small (always smaller than ventral spine).

Merus: 7-10 dorsal meral spines, medium-sized or small. Outer spine small.

Keel: Pr1: Posterior margin sloped or almost semi-abrupt (semi-abrupt on some specimens <20 OCL); profile usually angled down, sometimes flat or rounded; processes close and parallel. Keel after Pr1 lacking spines, sometimes slightly bumped.

Pr2: Approximately parallel and apart. Keel after Pr2 moderately pronounced without spines.

Pr3: Scoops absent (rarely very gradual); posterior edges moderately sharp to sharp; configuration almost parallel on some small specimens. Keel after Pr3 moderately pronounced and often irregular on large specimens, very pronounced on specimens <20 OCL.

Pr4: Scoops absent; posterior edges moderate to sharp and slightly convex; anterior edges moderately rounded to very angular.

Processes 3 and 4 narrow on specimens >20 OCL, broad on some smaller crayfish.

Setation: Moderate to light.

Punctation: Moderate to sparse on cephalon; moderate to dense on thorax.

Gastric mill: TAP count 3.5-4.0; TAA count 1.0-1.5; spread 2.0-3.0. Urocardiac ridges 6. Urocardiac ossicles rather shallow.

Coloration: Body green/blue dorsally, sometimes tinged with purple, paler ventrolaterally. Usually pale patches on dorsal and lateral cephalon; cephalic spines dark blue. Rostral spines pale. Abdomen often bluer than cephalothorax, somites bright blue laterally. Carpus of cheliped blue/green, mesal spines bright blue/purple, lateral spines white. Propodus and dactylus blue/purple. Fingertips pale yellow.

Body bright blue ventrally, with patches of orange and cream. Propodus of cheliped blue mesally, mesal spines blue/white, white on fingers, orange patch lateral to dactylar base. Dactylus pale blue or purple, white distally.

Variation between individuals in tones of blue and purple. Very small specimens pale brown or green.

Sexes: Males possess a cuticle partition.

No mature females have been collected. Female maturity presumably occurs at lengths greater than 30 OCL.

Distribution and biology. The species appears restricted to elevations above 740 m a.s.l. in the Clarke Range, in and near Eungella National Park, approximately 65 km west of Mackay, central coastal Queensland. The area is drained primarily by the Pioneer River. Vegetation in the species' range is tropical rainforest. The largest specimens were collected from a seepage at the type locality. The Eungella plateau is much higher than areas within 240 km to the north and 500 km to the south, and receives over 2400 mm of rainfall annually. The species is sympatric with a species of *Cherax* at the lower Eungella sites.

Etymology. Named after "Eungella" (Land of Cloud), the National Park on the Clarke Range, west of Mackay. The name is probably derived from the Biria aboriginal language (Dixon, 1972).

Remarks. Euastacus eungella has been collected only from a small area and does not display marked geographical variation.

The species is represented in collections by only 12 complete or near complete specimens with only one larger than 30 OCL. Two chelae, presumably from the same animal, are present in the QM collection and were undoubtedly borne by a specimen larger than 40 OCL. The propodus, dactylus and merus of a single large cheliped (mementos of a Park Ranger) were examined and measured, and also must have belonged to an animal larger than 40 OCL. Extrapolation of PropL/OCL ratios to the propodal lengths of the larger of the two museum chelae (45.5 mm) and the Ranger's specimen (46.8 mm) imply OCLs of 48-50 mm. Large specimens have been observed occasionally in the field (K. McDonald, pers. comm.).

Euastacus fleckeri (Watson)

Figures 7, 8

Astacopsis fleckeri Watson, 1935: 233-235, pl.34.—Watson, 1936: 52.—Flecker and Flecker, 1936: 18.

Euastacus fleckeri.—Clark, 1936: 17-18, pl. 3, fig. 17.—Clark, 1937: 186.—Clark, 1941: 19-20.—Riek, 1951: 378-379, 381.—Riek, 1969: 895.

Material examined. Holotype. Qld, Roots Ck near Mt Carbine in Mt Molloy district, 80 miles (130 km) west of Cairns, QM W581, ♂, OCL 102.8 mm. (There is some confusion regarding the identity of the type specimen. The male W581 is present in the jar bearing the type locality and holotype label. Watson (1935) originally designated the holotype as male, and Flecker and Flecker (1936) recorded the type as male. In a copy of the *Memoirs of the Queensland Museum* seen by me Watson's (1935) designation of the type as "male" has been amended by an unknown person to "female". Clark (1936) and Riek (1969) recorded the holotype as female and a female (QM W620, OCL 119.1 mm) also bears a type locality label. It is concluded here that the holotype is the male QM W581 and that confusion regarding sex has occurred subsequent to Watson's (1935) description.)

Other specimens. Qld. Mt Lewis near Cairns, P. Flecker, AM P13434, 2♂, 1♀; Mt Lewis, P. Flecker, AM P15528, 1♂; Leichhardt Ck tributary, cement road crossing above old forestry camp, Mt Lewis, (16°35'S, 145°19'E), 6 Jul 1981, G.J. Morgan and S.J. Harders, QM W10988, 2♀; Leichhardt Ck tributary beside old forestry camp, Mt Lewis, (16°35'S, 145°19'E), 7 Jul 1981, G.J. Morgan and S.J. Harders, QM W10988, 2♀; Head of Mossman R., 3 Jan 1936, A. Flecker, QM W608, W610, W612, W617, W619, W621, 6♀; North Queensland, QM W1469, 1♀. (The AM registry lists a "topotype" AM P10758 but this specimen could not be found. In any case, its locality of "upper reaches of Mossman R., north of Cairns" does not agree strictly with the type locality.)

Diagnosis. Male cuticle partition usually absent (see *Remarks*). Rostrum distinctly U-shaped (especially on large specimens) with sides parallel and base divergent. Rostral marginal spines in line reaching, or extending proximal to, midlength of carinae. Antennal squame widest at midlength, spines ab-

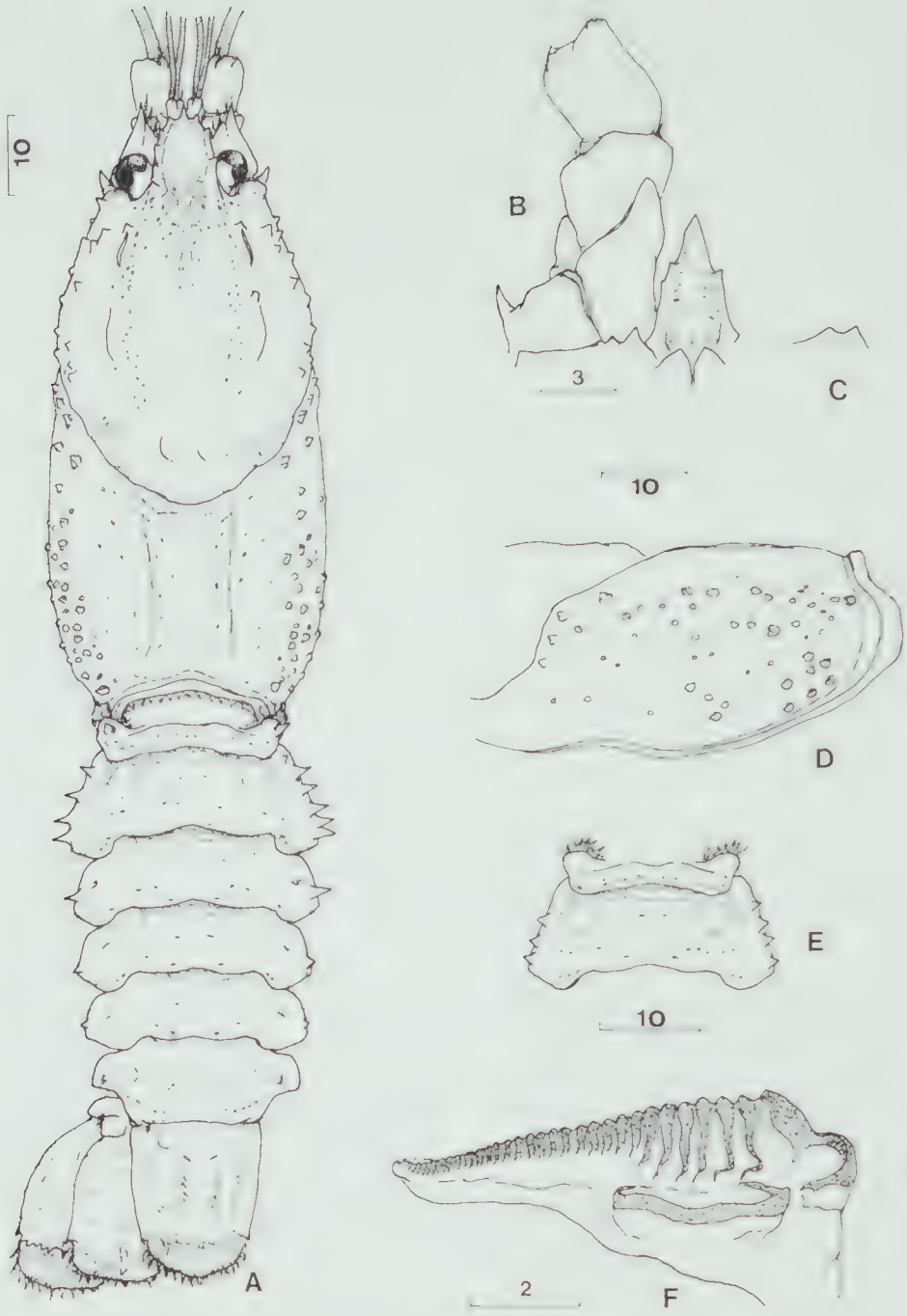

Figure 7. *Euastacus fleckeri.* (Types not available at time of illustration) A, dorsal view (♀, Mossman R., QM W619); B, ventral view cephalon (♀, Mossman R.); C, bifid coxopodite spine (♀, Mt Lewis, AM P13434); D, lateral view thorax (♀, Mossman R.); E, abdominal somites 1 and 2: D-L spine absent from somite 1, fewer blunter Li spines on somite 2 (♀, Leichhardt Ck, QM W10988); F, zygocardiac ossicle ("topotype", Mossman R., AM P10758, Francois collection).

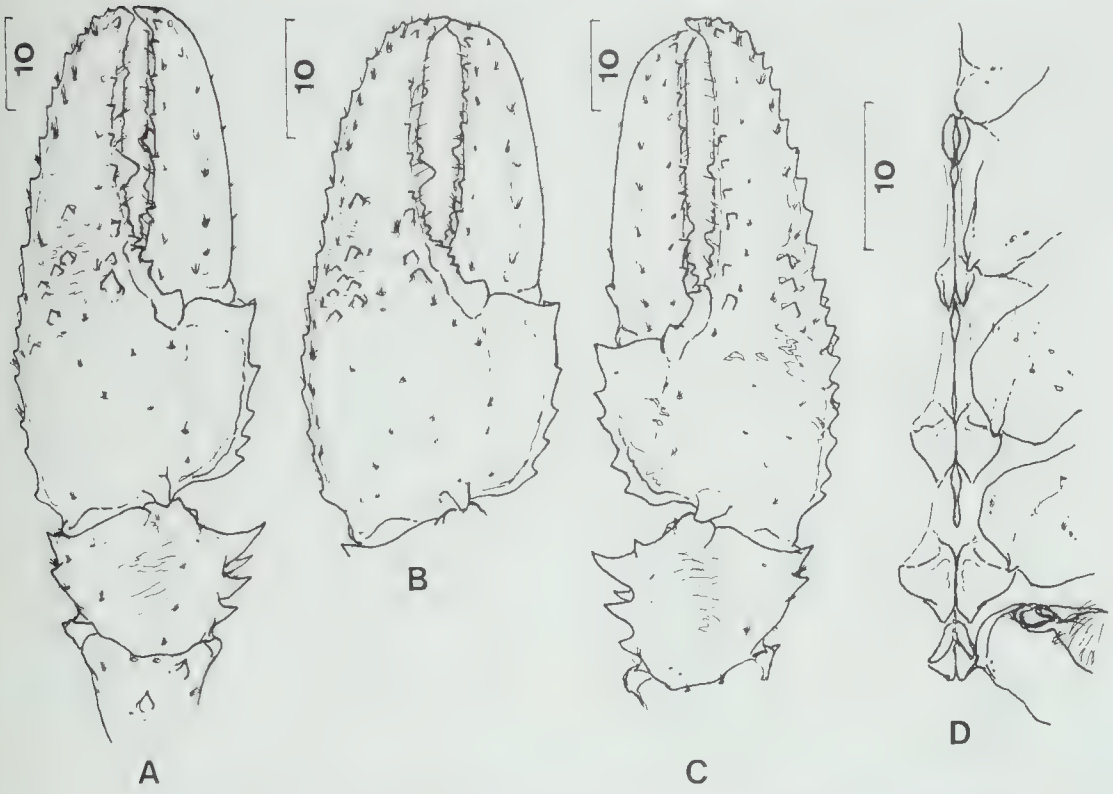

Figure 8. *Euastacus fleckeri*. A, dorsal view chela (♀, Mossman R.); B, chela: stouter (♀, Leichhardt Ck); C, chela: 4 mesal carpal spines, dactylar basal spine (regenerate) (♂, Mt Lewis, AM P13434); D, sternal keel (♂, Mt Lewis).

sent. Suborbital spine small to medium-sized. Thoracic spines/tubercles largest dorsally and very sparsely distributed over branchiostegites (vague on some specimens <40 OCL). D-L spine usually present on abdominal somite 1 (and rarely somite 6). D abdominal spines and abdominal boss absent. Tailfan spines absent. Lateral propodal spines in 2 to 1 row condition (ventral row poorly developed). 4-5 (rarely 6) mesal propodal spines. 0 or 1 dorsal apical propodal spine. Spines above propodal and dactylar cutting edges in rows reaching proximal to midlength of gape. Mesal dactylar spines absent. Carpal dorsal groove shallow. 3-4 (rarely 5) mesal carpal spines. Large mesoventral carpal spine. Keel Pr1 usually angled down and close. Pr3 and 4 narrow or just broad. TAP count 8.0-9.5.

Description. Maximum OCL: 119.1 mm.

Rostrum: Rostrum rather short, not reaching midlength of 3rd antennal segment on specimens >20 OCL, reaching midlength on specimens <20 OCL. Rostral sides approximately parallel, base divergent or very divergent and carinae short and spread, 3-4 (rarely 5) marginal spines per side, distributed to or proximal to midlength or full length of carinae; spines medium-sized or small and usually moderately pointed, blunt on some large specimens (probably abraded), rather sharp on some specimens <60 OCL. Acumen spine subequal to, or slightly larger than, marginal spines.

OCL/CL 0.82-0.89 i. RW/OCL 0.15-0.21 d.

Cephalon: Cephalon moderately spiny or spiny, with numerous small spines below postorbital ridges, or poorly spined on specimens <40 OCL. 1st postorbital spine an edge on specimens >80 OCL, small on some lesser individuals and medium-sized on some crayfish <40 OCL; 2nd spine small edge to small, sometimes on one side only. Suborbital spine small or medium-sized. Lateral margin of squame approximately straight; squame widest at midlength; marginal spines usually absent (one large specimen with lateral spine on both squames). Interantennal spine elongate on specimens >100 OCL, medium width on specimens 60-100 OCL, medium or broad on smaller specimens; spine margin scalloped or toothed; centre frequently punctate. Antennal basipodite spine absent; coxopodite spine medium-sized or small and bifid or serrated, usually pronounced mesally.

ScL/OCL 0.11-0.20 d.

Thorax: On specimens >40 OCL, small, moderately sharp to blunt spines or tubercles scattered irregularly over branchiostegites; spines larger and denser dorsally. Carapace sides lightly punctate. Specimens <40 OCL usually devoid of carapace ornamentation. 2-4 cervical spines; spines medium-sized or small and sharp or moderately pointed, tiny and blunt on some specimens <40 OCL; spines usually evenly spaced and similarly sized.

ArL/OCL 0.37-0.40. CaW/OCL 0.52-0.58. ArW/OCL 0.14-0.24 d. CaD/OCL 0.45-0.50 d.

Abdomen: Small or tiny D-L spine on somite 1 of specimens >60 OCL and some smaller animals; spine usually blunt, sometimes rather sharp. Subsequent somites lacking D-L spines (somite 6 of one very large specimen with tiny bump). D abdominal spines absent. Somite 2 with 3-6 Li spines on specimens >40 OCL, 2 or 3 spines on smaller specimens; somites 3-5 of specimens >40 OCL and some 20-40 OCL with single Li spine; Li spines large to small on specimens >60 OCL, medium-sized to tiny on lesser animals, decreasing posteriorly; spines very sharp or sharp on animals >40 OCL, moderately pointed to blunt on smaller crayfish. Lii spines on somites 3-5 of some large crayfish, spines small or tiny and moderately pointed to blunt; tiny Lii spine on somite 6 of most specimens >60 OCL. Abdominal boss absent.

AbdW/OCL ♂ 0.49-0.54 d, ♀ 0.52-0.56 i. OCL/L 0.37-0.46 i.

Tailfan: Tailfan spines absent; faint setal bumps along margins of telson and uropods. Standard spines very small or small, medium-sized on smallest specimen.

TeL/OCL 0.34-0.41 d.

Chelae: Chelae elongate to stout (elongate chelae probably regenerate). Teeth well developed on very large specimens.

Propodus: Lateral propodal spines in 2 to 1 row condition, ventral row often poorly developed; spines medium-sized or small and rather sharp. Lateral spine ridge vague or absent. Usually 5 mesal propodal spines, rarely 4 or 6. 0 or 1 dorsal apical propodal spine. 2-6 spines above cutting edge of specimens >40 OCL, 1-3 on specimens 20-40 OCL, spines absent on animal <20 OCL; spine row extending proximal to midlength or full gape of chela, usually with distinct gap between propodal apex and distalmost spine; spines small to large, usually largest proximally, near dactylar articulation. Dorsally, 1 or 2 medium-sized spines lateral to dactylar base, with 3-7 or more lateral blunt spines often forming irregular row parallel to propodal lateral edge; ventrally, 2-4 medium-sized or small spines, very close to cutting edge. Spines absent proximal to dactylar articulation; precarpal spines absent.

PropL/OCL ♂ 0.84-0.97 i, ♀ 0.83-0.91 i. PropW/PropL (0.34)0.38-0.52.PropD/PropL (0.23)0.25-0.39 d.

Dactylus: 6-9 spines above dactylar cutting edge on specimens >40 OCL, 1-2 spines on smaller specimens; spines distributed along full gape of chela (smallest animal with single basal spine); spines medium-sized to large. Extra dactylar dorsal spines absent. Apical and basal mesal dactylar spines absent (two specimens with single marginal basal spine on regenerate chelae). Dactylar groove absent or shallow on specimens >40 OCL, distinct on some smaller specimens.

DactL/PropL 0.53-0.61.

Carpus: Dorsolongitudinal groove very shallow. 3-4 (rarely 5) mesal carpal spines; 1st (distal) spine usually smaller than 2nd. 2 lateral carpal spines, medium-sized to large. Articulation and dorsal carpal spines absent. Ventral carpal spine medium-sized, rarely large. Large mesoventral spine larger than ventral spine, and usually 2-3 ventromesal spines, 1 of which sometimes also large.

Merus: 5-9 dorsal spines, small or medium-sized. Outer spine small or tiny.

Keel: Pr1: Posterior margins very sloped; ventral edges angled down or slightly angled back near anterior margins; processes close (or very slightly apart) and closed or parallel. Keel after Pr1 sometimes with slight spine.

Pr2: Usually open or very open, occasionally parallel; processes apart. Keel after Pr2 slightly pronounced or saddle-shaped.

Pr3: Scoops absent or gradual; posterior edges moderate to rounded (sharp on smallest specimen). Keel after Pr3 moderately pronounced anteriorly.

Pr4: Scoops absent; posterior edges moderate to moderately sharp (sharp on smallest specimen) and straight, slightly convex or irregular; anterior edges moderate to angular.

Processes 3 and 4 narrow or just broad on specimens >60 OCL, broad on smaller animals.

Setation: Light.

Punctation: Moderate to dense, but faint, on cephalon; dense on thorax.

Gastric mill: TAP count 8.0-9.5; TAA count 0.0; spread 8.0-9.5. Teeth small and close. Urocardiac ridges 8-10.

Coloration: Body very dark green with brown tinges dorsally, deep blue ventrolaterally. Thoracic and cephalic spines red or orange. Rostral carinae orange. Anterior margins of abdominal somites bright blue (visible when abdomen flexed). Li spines red. Carpus of cheliped blue/green with red tipped spines. Propodus dark blue/green with some mottling, red spines, mesal edge blue. Dactylus green/red. Finger tips red.

Body light blue and red ventrally. Carpus of cheliped bright blue with red spines. Propodus blue, greener at mesal edge, red spines.

Sexes: Most males lack a cuticle partition but one specimen possesses a thin partition (see *Remarks*).

One female in the 40-60 OCL range displays open gonopores, though 2 specimens in the 60-80 OCL range are unopen. All females are mature when >80 OCL.

Distribution and biology. The species occurs in rainforest streams at elevations above 1000 m a.s.l. in a small area west of Mossman, north Queensland, from Mt. Lewis in the south to the Mt Spurgeon region in the north, a distance of 20 km. The high country is drained by the Mossman River to the east and tributaries of the Mitchell River to the west and south. Creeks are well shaded and log and leaf litter are abundant. Lower country between Mt

Lewis and Kuranda separates *E. fleckeri* from *E. balanensis* of the Atherton Tableland. Streams in this lower area support species of *Cherax, Macrobrachium* and *Atyoida*.

Remarks. Of the four males examined, three lack the coxal cuticle partition and one medium-sized specimen possesses it. Two of the former three males are large (>60 OCL) but the third is small (<20 OCL); hence it cannot be argued that the partition breaks down with age. Further sampling may reveal that the specimen with a partition is aberrant and atypical of the species, but the inconsistancy cannot be resolved at this stage.

Euastacus hystricosus Riek

Figures 9, 10

Euastacus hystricosus Riek, 1951: 380-381.—Riek, 1956: 1-2.—Riek, 1969: 896.

Material examined. Qld. Elaman Ck, Maleny, 8 Oct 1953, E.F. Riek, AM P13044, 2♂, 4♀; Mary R., 1974, QM W4643, 1♂; Conondale Ra., QM W2027, 1♂; Conondale, 25 Apr 1943, AM P11932, 2♀; Sunday Ck, Kilcoy, QM W1988, 1♂, 1♀; Kondalilla Nat. Park, Aug 1974, QM W5457, 1♀; Tributary of Little Yabba Ck, Kenilworth State Forest, (26°39′S, 152°37′E), 10 Mar 1981, G.J. Morgan and S.J. Harders, QM W10965, 1♂; Six Mile Ck, Kenilworth S.F., (26°46′S, 152°36′E), 11 Mar 1981, G.J. Morgan and S.J. Harders, QM W10966, 1♂; Sunday Ck, Kenilworth S.F., (26°44′S, 152°32′E), 12 Mar 1981, G.J. Morgan and S.J. Harders, QM W10962, 1♂; Kilcoy Ck at Rum Crossing, tributary Brisbane R., (26°46′S, 152°36′E), 13-14 Mar 1981, G.J. Morgan and S.J. Harders, QM W10963, 1♂, 2♀.

Diagnosis. Male cuticle partition present. Rostral marginal spine row reaching proximal to midlength of carinae. Rostral base parallel to divergent, carinae of medium length to long. Antennal squame widest at or slightly proximal to midlength. Squamal spines absent. Suborbital spine usually large or very large. Thoracic spines medium-sized, in zone or irregular rows. General tubercles medium-sized or large, moderately to sparsely distributed. 3-4 large and sharp Li spines on abdominal somite 2 (>40 OCL). Several sharp D spines on abdominal somites 5 and 6 (>40 OCL). Abdominal boss present. 8-15 large telsonic surface spines. Marginal spines present on outer ramus of uropod. Lateral propodal spines in 2 to 1 row condition. 1 dorsal apical propodal spine (>40 OCL). Spines above propodal cutting edge usually apical (row sometimes reaching to or slightly proximal to midlength of gape). Usually 5 mesal propodal spines. Spines above dactylar cutting edge apical or in row reaching proximal to midlength of gape. 1 dorsal mesal dactylar basal spine. 1-3 marginal mesal dactylar basal spines. 3-4 apical mesal dactylar spines. Dorsolongitudinal groove of carpus deep. 2 mesal carpal spines. Ventromesal carpal spines much smaller than ventral spine. Keel Pr1 abrupt and apart. TAP count 5.0-6.0. [Usually 2 distinct spines on each side of epistome].

Description. Maximum OCL 138.6 mm.

Rostrum: Rostrum not reaching or just reaching midlength of 3rd antennal segment on specimens >60 OCL, to or distal to midlength of segment on specimens 40-60 OCL, distal to midlength or to end of segment on smaller animals. Rostral sides parallel or slightly convergent, base parallel to divergent, usually slightly divergent. Carinae medium length to long, not markedly spread. Rostral marginal spines numbering 3 (rarely 2)-4 per side, in row reaching proximal to midlength of carinae; spines medium-sized to large and moderately sharp. Acumen spine slightly larger to much larger than marginal spines.

OCL/CL 0.73-0.87 i. RW/OCL 0.15-0.23 d.

Cephalon: Rather poorly spined to spiny, usually with 1 or 2 large, sharp spines ventral to postorbital ridge with some smaller spines/bumps. First postorbital spine small to medium-sized on specimens >100 OCL, usually large or very large on specimens <80 OCL. 2nd postorbial spine an edge on very large specimens, usually small or medium-sized on specimens 60-80 OCL and large on smaller specimens. Suborbital spine medium/large to very large. Lateral margin of squame convex to straight; squame widest at or slightly proximal to midlength on specimens >40 OCL, distinctly proximal on smaller animals; marginal spines absent. Interantennal spine of medium width to broad, marginally serrated or slightly (rarely distinctly) toothed. Antennal basipodite spine medium-sized to large on most specimens >60 OCL (largest specimen with only small spine) and large or very large on specimens <60 OCL. Coxopodite spine small to medium-sized, rarely large, usually bifid, occasionally serrated, with mesal point most pronounced.

ScL/OCL 0.13-0.33 d.

Thorax: On specimens >40 OCL, 8-14 dorsal thoracic spines in zone or 2 irregular rows. Spines medium-sized to medium/large and usually sharp, especially near posterior of carapace, with moderate or blunt spines dorsally. Larger specimens in 20-40 OCL range with medium-sized or small, blunt, rounded or flat spines. Spines vague or absent on specimens close to or <20 OCL. General tubercles medium-sized to large on specimens >40 OCL, moderate to sparse in density. Specimens <40 OCL with very small to medium-sized, very sparse tubercles; on very small animals, tubercles vague or absent. Usually 1 sharp, medium to very large cervical spine, though 2nd smaller spine sometimes present on small animals.

ArL/OCL 0.38-0.41. CaW/OCL 0.58-0.64 i. ArW/OCL 0.12-0.19 d. CaD/OCL 0.51-0.57 d.

Abdomen: Sharp, medium-sized or large D-L spine on somite 1 of specimens >40 OCL (tiny spine on some smaller animals; one medium-sized specimen with 2 D-L spines on one side). D spine absent on somite 1. 3-4 Li

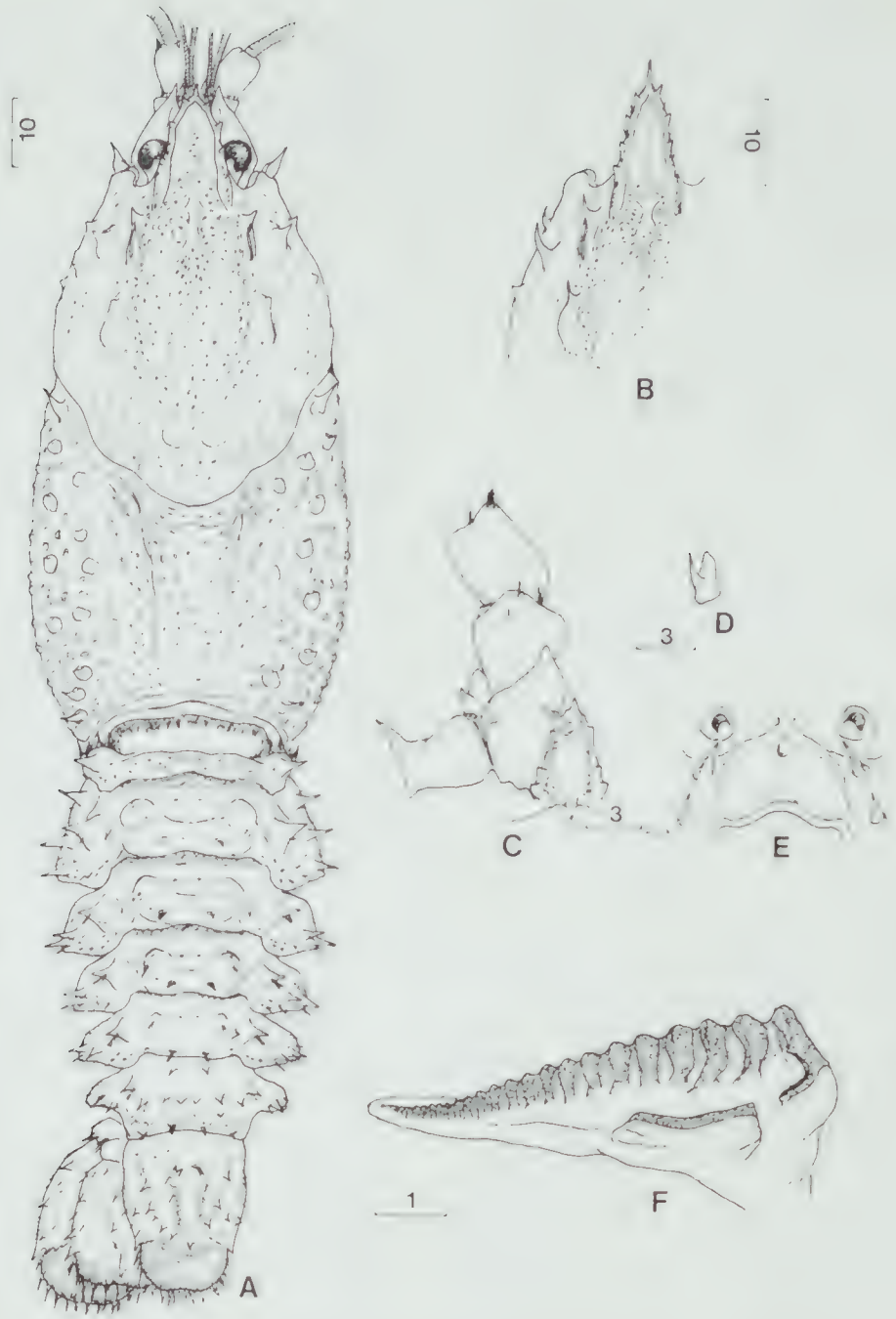

Figure 9. *Euastacus hystricosus*. (Types not available for illustration). A, dorsal view (♂, tributary of Little Yabba Ck, QM W10965); B, cephalon: rostrum more elongate with more numerous spines, larger cephalic spines, (allometry) (♂, Sunday Ck, QM W10962); C, ventral view cephalon (♂, tributary of Little Yabba Ck); D, very large basipodite spine (allometry) (♂, Six Mile Ck, QM W10964); E, epistome: 2 large spines per side (♂, Sunday Ck); F, zygocardiac ossicle (♀, Maleny, AM P13043, Francois collection).

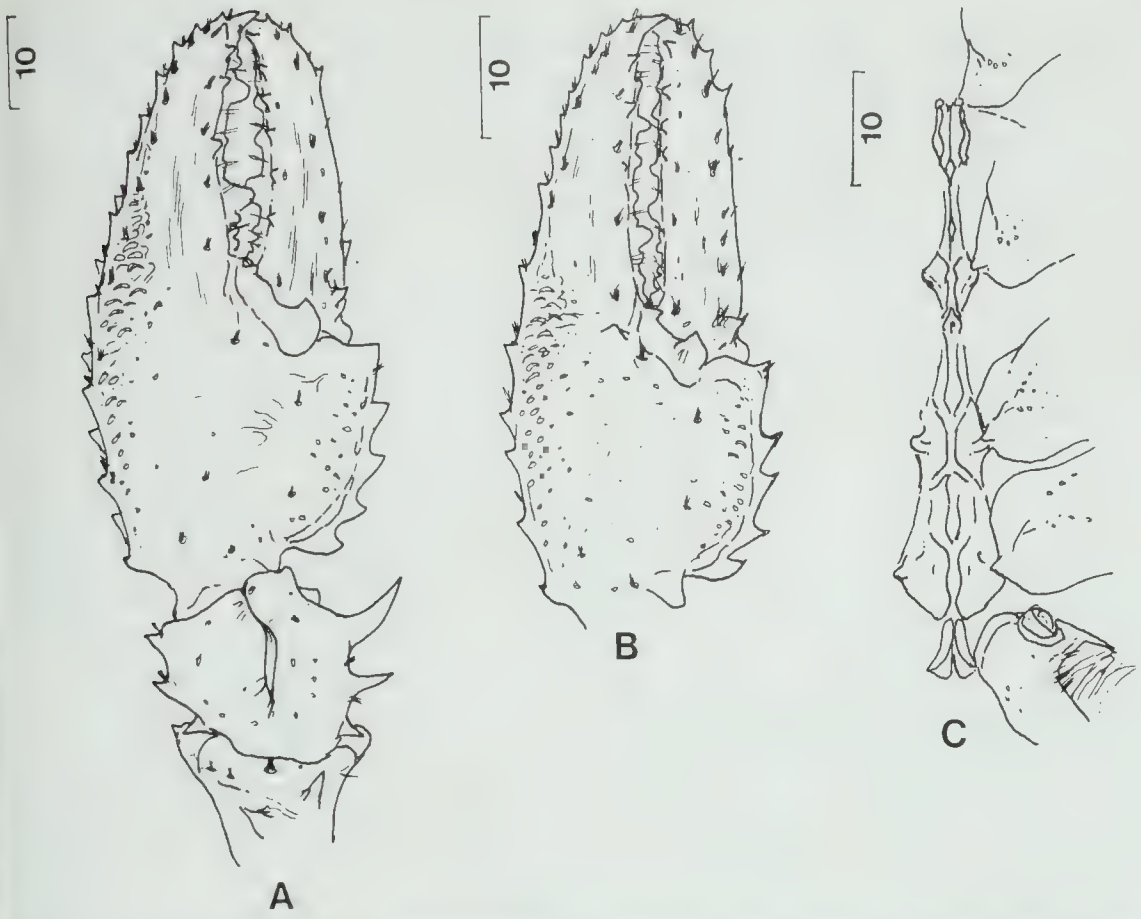

Figure 10. *Euastacus hystricosus*. A, dorsal view chela (♂, tributary of Little Yabba Ck); B, chela: more elongate (allometry), marginal mesal dactylar basal spine absent, apical propodal spine absent, small spine lateral to dactylar base (♂, Six Mile Ck); C, sternal keel (♂, tributary of Little Yabba Ck).

spines on somite 2 of specimens >40 OCL and 2-3 spines on most specimens 20-40 OCL. Somites 3-5 with single Li spine (outer Lii spine on somite 6 approaching Li position). Li spines very sharp and very large or large on anterior somites of specimens >40 OCL, decreasing in size posteriorly. On smaller specimens, Li spines medium-sized to tiny and sharp to very blunt. Somites 3-6 of specimens >40 OCL and some smaller animals with 1-2 Lii spines per side. Lii spines very large to medium-sized on specimens >60 OCL, medium to small on specimens 40-60 OCL and small or tiny when present on smaller animals; Lii spines very sharp, or blunt on specimens 20-40 OCL. 1 D-L spine on somites 2-5 of specimens >40 OCL; vague or absent on smaller specimens. D-L spines very large to medium-sized, decreasing to posterior, and very sharp. D spine absent from somites 2-4, distinct boss sometimes approaching blunt spine condition. On somite 5, 1-2 small D spines sometimes present. Somite 6 of specimens >40 OCL with 2-4 D-L and 3-5 D spines. Spines medium-sized or small, very sharp to moderately pointed. Spines vague or absent on specimens 20-40 OCL. Specimens <20 OCL probably lacking abdominal spination.

AbdW/OCL ♂ 0.48-0.56 d, ♀ 0.55-0.61 i. OCL/L 0.36-0.44 i.

Tailfan: 8-15 dorsal telsonic surface spines. Spines very large or large on specimens >40 OCL, often medium-sized on specimens 20-40 OCL. Marginal telsonic spines usually absent, though 1 large spine sometimes present on 1 or both telsonic margins. 1-3 surface spines on inner ramus of uropod, spines very large or large on specimens >40 OCL, medium-sized or small on smaller animals. 2-6 large marginal spines on inner ramus of specimens >40 OCL and on some smaller individuals. 3-6 marginal spines on outer ramus of uropod of specimens >40 OCL; on smaller animals, spines medium-sized or small when present, vague or absent on some very small specimens. Standard telsonic spines small to medium-sized on specimens >100 OCL, medium to large on smaller specimens. Frequently large spine on base of uropods.

TeL/OCL ♂ 0.33-0.40 d, ♀ 0.38-0.43 d.

Chelae: Chelae of specimens >40 OCL rather stout to elongate, sometimes very elongate on smaller animals. Teeth well developed on most specimens >60 OCL.

Propodus: Lateral propodal spines in 2 to 1 row condition, ventral row often poorly developed on very small specimens. Lateral spines medium-sized to large, usually sharp. Lateral spine ridge present. Usually 5 mesal propodal spines, though distalmost spine often poorly developed. Usually 1 dorsal apical spine on specimens >40 OCL, absent on smaller animals. 2-5 spines above propodal cutting edge on specimens >40 OCL; spines medium-sized or large and usually apical, spine row sometimes reaching to midlength (rarely slightly proximal to midlength) of gape. On specimens 20-40 OCL, 0-2 medium or small apical spines above cutting edge. 0-1 spine lateral to dactylar base dorsally; when present, spine large to small; lateral propodal bumps weakly developed. Ventrally, 1-3 large to small spines lateral to dactylar base (spine rarely absent). Spines absent proximal to dactylar articulation; precarpal spines absent.

PropL/OCL ♂ 0.90-1.06 i, ♀ 0.86-0.95. PropW/PropL (0.33)0.35-0.44 id. PropD/PropL 0.22-0.26.

Dactylus: 4-7 spines above cutting edge of dactylus of specimens >60 OCL, 2-5 spines on specimens 40-60 OCL, 0-3 on animals 20-40 OCL. Spines large or medium-sized, and apical or in row reaching to or proximal to midlength of gape. One very large specimen with extra dorsal dactylar spine on larger chela. 1 dorsal mesal basal spine on all specimens. Usually 1-3 marginal mesal basal spines; some specimens (especially small animals) lacking spines on one chela and one large animal with 4 on its smaller (probably regenerate) chela. Basal spines medium-sized or large and usually very sharp. 3-4 apical mesal spines. Dactylar groove absent or vague on specimens >40 OCL, light on smaller specimens.

DactL/PropL 0.52-0.58.

Carpus: Dorsolongitudinal groove deep. 2 mesal carpal spines; distalmost (1st) distinctly larger and slightly offset ventrally to 2nd. Two lateral carpal spines, medium-sized or large. Articulation and dorsal carpal spines absent. Ventral spine very large. 1 (rarely 2) small or tiny ventromesal spine(s).

Merus: 6-9 large dorsal meral spines. Outer spine medium-sized on specimens >40 OCL, large or very large on smaller individuals.

Keel: Pr1: Posterior margin abrupt (semi-abrupt on some small specimens); ventral profile usually irregular and rounded, flat, angled down or slightly back. Processes apart or very apart and parallel or closed. Keel after Pr1 frequently with spine.

Pr2: Open or very open. Keel after Pr2 usually pronounced anteriorly, sometimes with low spine.

Pr3: Distinct scoops; posterior margin usually rounded, though some specimens <40 OCL with moderately sharp processes. Keel after Pr3 pronounced and uneven in profile and moderate to sharp.

Pr4: Scoops usually slight, sometimes absent on small specimens. Posterior margins rounded to moderately sharp; anterior margins rounded to moderately curved on specimens >60 OCL, angular on some smaller specimens. Bases usually irregular, sometimes approximately straight.

Processes 3 and 4 narrow on specimens >100 OCL, broad on smaller animals.

Setation: Light.

Punctation: Moderate to moderately dense on large animals, dense on specimens <60 OCL.

Gastric mill: TAP count 5.0-6.0; TAA count 1.0-1.5; spread 3.5-4.5 (rarely 5.0). Urocardiac ridges 8-10 (number usually increasing with size).

Coloration: Body dark green dorsally. Thoracic spines slightly darker and general tubercles pale orange/green. Sharp abdominal and tailfan spines tipped with orange. Carpus and propodus of cheliped dark green, propodus with red, orange or yellow distally. Fingers orange and yellow.

Body orange and green ventrally. Carpus of cheliped dark green. Propodus orange grading to yellow distally, dark green mesally. Dactylus orange and yellow.

Sexes: Males possess a (usually wide) cuticle partition. The two males in the 40-60 OCL range collected in this study ejected spermatophores indicating sexual maturity.

Females in the 60-80 OCL size range have open gonopores, one being berried. Females in the 20-40 OCL range have closed gonopores. It is likely that female maturity occurs at lengths around 60 OCL.

Distribution and biology. The species inhabits streams in wet sclerophyll and rainforests at elevations above 550 m a.s.l. in the Conondale Range and Maleny areas west of Nambour, south-east Queensland. The species occurs in the Mary River system and was recently also collected from a tributary of the Brisbane River. Berried females have been observed in winter and spring. The one museum specimen with eggs was collected in August. *Euastacus hystricosus* is frequently sympatric with a species of *Cherax*, particularly at lower elevations of its range.

Remarks. The range and habitat of *E. hystricosus* is very limited and this large crayfish is relatively constant in morphological characters with no obvious geographical variation.

The holotype and allotype of *E. hystricosus* have been lost from the QM (fide Riek, 1969: 896) and could not be found for this study. Riek (1956: 1-2; 1969: 896) named lectotypes (including a "holotype", "allotype" and "paratypes") from Elaman Creek, Maleny (AM P13044). This move was invalid as lectotypes can be designated only from a series of syntypes. A single neotype may be nominated if the type series is lost but "only in exceptional circumstances where a neotype is necessary in the interests of stability of nomenclature" (International Code of Zoological Nomenclature, Art. 75a). It is here regarded that a neotype need not be designated for *E. hystricosus*.

Euastacus robertsi Monroe

Figures 11, 12

Euastacus robertsi Monroe, 1977: 65-67, pl. 19.

Material examined. Holotype. Qld, Horans Ck, 1050 m, Mt Finnigan National Park, north-east Queensland, 27-29 Nov 1975, L. Roberts, R. Monroe and G. Ingram, QM W5323, ♂, OCL 42.3mm.

Paratypes. Qld, type locality, QM W5324, 7♂, 11♀.

Other specimens. Qld, Horans Ck, 3500 ft, Mt Finnigan Nat. Park, 9 Nov 1974, QM W5076, 1♂; Horans Ck, 2400 ft, 10 Nov 1974, QM W5075, 1♀; Hilda Ck, Thornton Peak, 24-27 Sep 1984, G. Monteith and R. Leggett, QM W11554-W11557, 4♂, 2♀.

Diagnosis. Male cuticle partition present. Rostrum not distinctly U-shaped, sides usually convergent and base divergent. Rostral marginal spines in row reaching, or extending proximal to, midlength of carinae. Antennal squame widest at or slightly distal to midlength; spines absent. Suborbital spine medium-sized to large. Thoracic tubercles/spines small or very small (larger ventrally), and very sparse. D-L spine usually absent on abdominal somite 1. D abdominal spines and abdominal boss absent. Tailfan spines absent. 2 lateral propodal spine rows; 6-9 mesal propodal spines. 7-9 dorsal apical propodal spines (specimens >30 OCL). Spines above propodal and dactylar cutting edges in rows reaching full length of gape. Mesal dactylar spines absent. Dorsolongitudinal carpal groove shallow. 4-5 mesal carpal spines, distalmost often smaller than 2nd. Large mesoventral carpal spine. Keel Pr1 angled down, and close. Keel Pr3 and 4 broad or very broad. TAP count 4.5-5.0.

Description. Maximum OCL: 50.8 mm.

Rostrum: Rather short, not reaching midlength of 3rd antennal segment. Rostral sides convergent or slightly convergent, parallel on largest specimen; base divergent or very divergent and carinae short and spread. 2-4 marginal spines per side, distributed to or proximal to midlength or full length of carinae; spines medium-sized or small, rounded on specimens >30 OCL, moderately pointed or rounded on smaller animals. Acumen spine slightly larger than marginal spines.

OCL/CL 0.83-0.89 i. RW/OCL 0.14-0.20 d.

Cephalon: Spination moderate on specimens >30 OCL, weak on most smaller individuals, with several small spines below postorbital ridges. 1st postorbital spine an edge to small on specimens >20 OCL, small or medium-sized on specimens <20 OCL; 2nd postorbital spine edge or small edge. Suborbital spine medium-sized or large. Lateral margin of squame straight or slightly convex or concave; squame widest at or slightly distal to midlength and lacking marginal spines. Interantennal spine elongate on large specimens, medium width on animals 30-40 OCL, broad on many specimens <30 OCL; spine margin rather smooth with 1-2 small spine(s) each side of apex, centre frequently punctate. Antennal basipodite spine absent; coxopodite spine small, rarely medium-sized, and bifid or serrated.

ScL/OCL 0.14-0.19 d.

Thorax: Small or medium-sized tubercles or spines sparsely distributed over sides of carapace, usually larger ventrally; tubercles vague on specimens <20 OCL. 2-4 cervical spines per side, small or tiny and similarly sized and moderately pointed to blunt; spines vague or absent on specimens <20 OCL.

ArL/OCL 0.41-0.44. CaW/OCL 0.53-0.58 i. ArW/OCL 0.14-0.17 d. CaD/OCL 0.43-0.50 d.

Abdomen: Tiny, blunt D-L spine sometimes on somite 1 of large specimens, though absent on largest animal and holotype; subsequent somites lacking D-L spines. D spines absent. Somite 2 with 4-5 Li spines on specimens >30 OCL, 1-4 on specimens 20-40 OCL, 0-3 on animals <20 OCL; somites 3-5 of animals >30 OCl and some 20-30 OCL with single Li spine; Li spines small or tiny and moderately pointed or blunt on specimens >30 OCL, blunt or very blunt on smaller animals. Lii spines absent. Dorsal boss absent.

AbdW/OCL 0.49-0.53. OCL/L 0.38-0.43 i.

Tailfan: Tailfan spines absent, faint setal bumps along margins of telson and uropods. Standard spines small or very small.

TeL/OCL 0.32-0.39 d.

Chelae: Chelae intermediate in shape to very stout, elongate on some very small animals <20 OCL. Teeth well developed on specimens >30 OCL.

Propodus: 2 lateral propodal spine rows or 2 to 1 row condition on some specimens <20 OCL; lateral spines small and rather sharp. Lateral spine ridge vague or absent. 6-9 mesal propodal spines. 7-9 dorsal apical spines on normal chelae of specimens >30 OCL, usually 3-5 on specimens 20-30 OCL and 0 or 1 spine on specimens <20 OCL. 5-10 spines above cutting edge of specimens >30 OCL, 1-5 on smaller specimens; spines distributed along full gape of chela, sometimes only 1 proximal spine present on specimens <20 OCL; spines medium-sized to large on specimens >30 OCL, small to medium on lesser animals; spines usually largest proximally. Dorsally, 1-3 medium-sized spines and many smaller spines lateral to dactylar base, or many medium-sized spines; ventrally, 3-5 medium or small spines very close to cutting edge of propodus, spines vague or absent on very small animals. Spines absent proximal to dactylar articulation; precarpal spines absent.

PropL/OCL 0.76-0.97 i. PropW/PropL(0.38)0.44-0.51. PropD/PropL 0.27-0.37.

Dactylus: 5-9 spines above cutting edge of dactylus of specimens >30 OCL, 1-5 on smaller animals, rarely absent on very small specimens; spines distributed along full gape of chela (sometimes 1 proximal spine on small specimens), spines medium-sized to small with largest spines proximal. Some specimens >30 OCL with 1 or 2 extra dorsal dactylar spines. Mesal dactylar basal spines absent. Apical mesal spines absent except on some regenerate chelae (one specimen with 1 apical dactylar spine on normally proportioned chela, but dactylus also with additional dor-

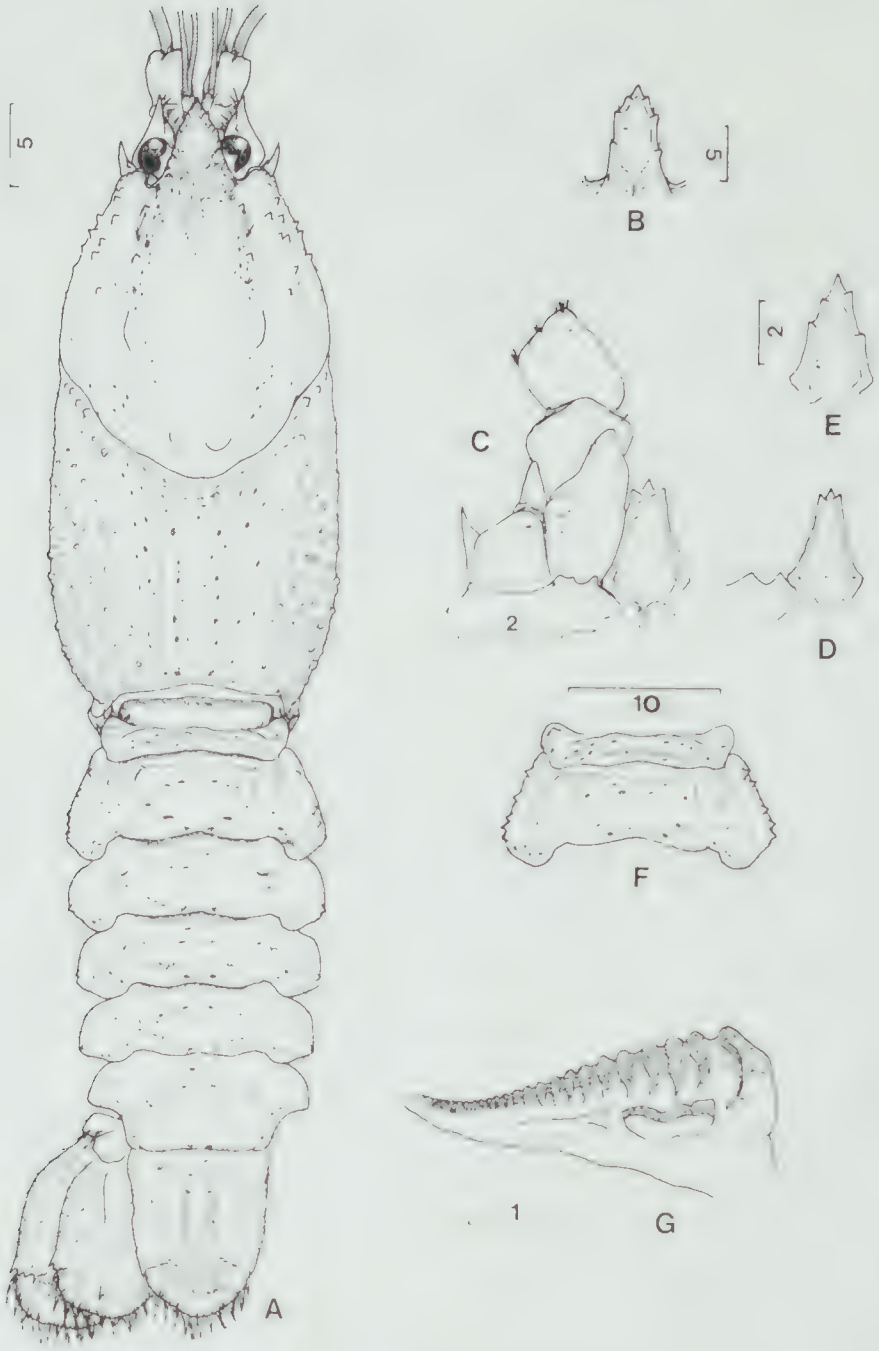

Figure 11. *Euastacus robertsi*. (Holotype not available at time of illustration.) A, dorsal view (paratype ♀, Mt Finnigan, QM W5324); B, rostrum: margins nearly parallel (♀, Thorntons Peak, QM W11554); C, ventral view cephalon (paratype ♀); D, more elongate interantennal spine and bifid coxopodite spine (paratype ♂); F, interantennal spine with 2 lateral spines per side (♀, Thorntons Peak); F, abdominal somites 1 and 2: small D-I spine on left side of somite 1, larger Li spines (paratype ♂); G, zygocardiac ossicle (paratype ♂).

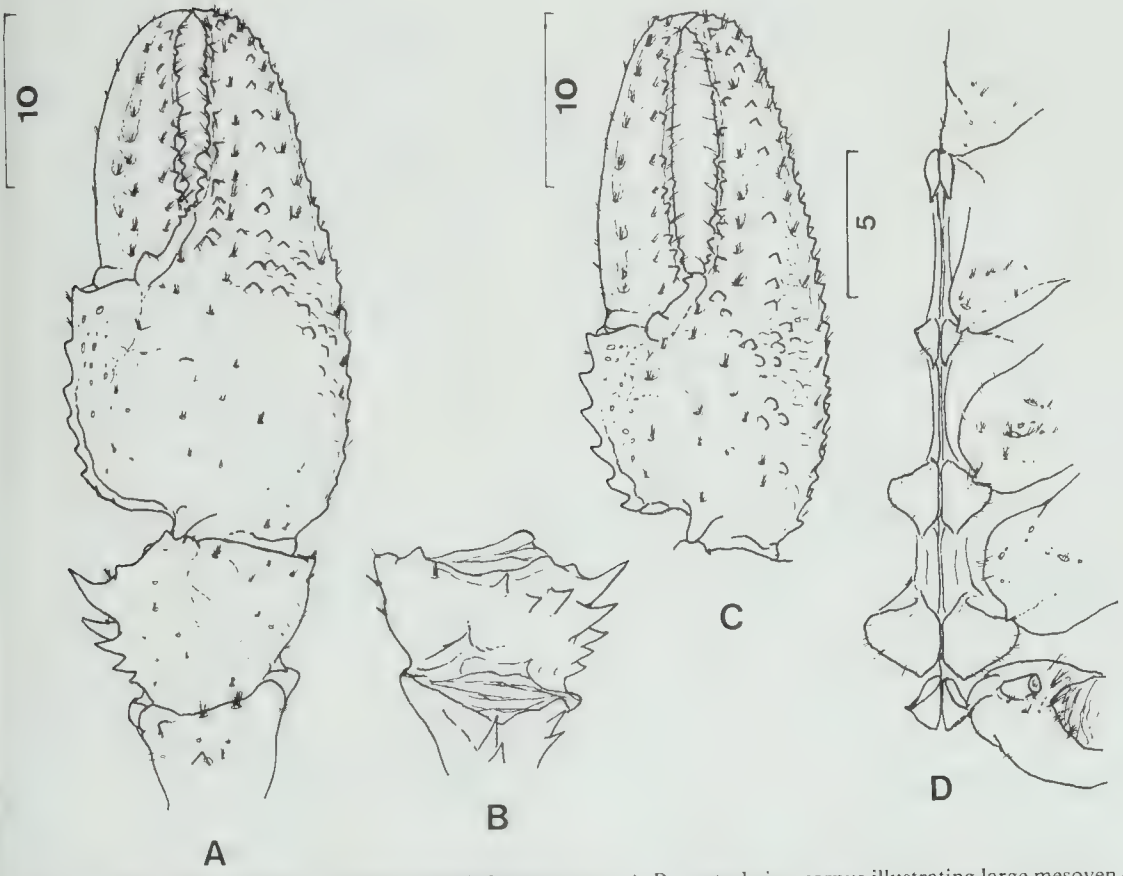

Figure 12. *Euastacus robertsi*. A, dorsal view chela (paratype ♂); B, ventral view carpus illustrating large mesoventral spine (paratype ♂); C, chela: more elongate, apical dactylar spine, (regenerate) (paratype ♂); D, sternal keel (paratype ♂).

sal spine near propodal articulation; both spines atypical of species). Dactylar groove present, deep on some specimens <20 OCL.

DactL/PropL (0.42)0.45-0.58.

Carpus: Dorsolongitudinal groove very shallow (deeper on some regenerate chelae). 4-5 mesal carpal spines; distalmost spine frequently smaller than 2nd, successive spines diminshing in size. Usually 1 or 2 small or tiny lateral carpal spines, sometimes vague. Articulation and dorsal carpal spines absent. Ventral carpal spine small or medium-sized. Several small ventromesal spines (usually 4-6), and mesoventral spine larger than ventral spine.

Merus: 7-12 small dorsal spines. Outer meral spine small or tiny.

Keel: Pr1: Posterior margins very sloped; ventral edges angled down; processes close (or slightly apart) and parallel or closed. Sometimes slight blunt spine on keel after Pr1.

Pr2: Open or very open. Keel after Pr2 usually saddle-shaped.

Pr3: Scoops absent; posterior edges sharp to moderately edged, occasionally rounded. Keel after Pr3 pronounced, often uneven.

Pr4: Scoops absent; posterior edges sharp and straight to convex; anterior edges angular.

Processes 3 and 4 broad or very broad.

Setation: Moderate to light; setae short.

Punctation: Dense, but rather faint, on cephalon; very dense on thorax.

Gastric mill: TAP count 4.5-5.0; TAA count 1.0; spread 3.0-4.0. Urocardiac ridges 6-7.

Coloration: "Colour in life: Dull blue-purple with a longitudinal red brown mark dorsally on the carapace and the tips of larger spines" (Monroe, 1977).

Sexes: Males possess a cuticle partition. Only the largest female (OCL 50.8) has open gonopores and is berried; female maturity probably occurs at sizes between 30 and 50 OCL.

Distribution and biology. The species is known only from elevations above 1000 m a.s.l. at Mt Finnigan and Thornton Peak, 40 km and 80 km respectively south of Cooktown, north Queensland. Monroe (1977) briefly described aspects of the

habitat at the type locality and though no mention was made of vegetation, it is probably tropical rainforest. The berried female was collected in September.

Remarks. Monroe's (1977) description of *E. robertsi* was detailed but the species is redescribed here to facilitate comparison with other species of *Euastacus* and to document allometric variation in characters.

Euastacus robertsi is known only from a small area and little geographic variation is evident. Specimens from Thornton Peak have less triangular rostra and more elongate chelae than those from the type locality.

Euastacus sulcatus Riek

Figures 13, 14

Astacopsis serratus. – Watson, 1935: 235 (in part, Mt Tamborine and Lamington National Park as localities).

Euastacus sulcatus Riek, 1951: 379. – Riek, 1969: 895.

Euastacus cunninghami Riek, 1951: 379-380. – Riek, 1956: 1. – Riek, 1969: 895.

Material examined. Holotype. Qld, Binna Burra, Lamington National Park, south-east Queensland, Jan 1943, E.F. Riek, AM P11921, ♂, OCL 78.9 mm.

Allotype. Type locality, AM P11922, ♀, OCL 81.1 mm.

Paratypes. Type locality, 1♂, 1♀; Type locality, AM P13030, 25 specimens; Binna Burra, 1 Dec 1943, E.F. Riek, AM P11924, 1♀; Binna Burra, Jan 1944, E.F. Riek, AM P11923, 1♂, 2♀.

Other specimens. Qld. Bell Bird Ck, near Binna Burra (28°12'S, 153°11'E), 2 May 1981, G.J. Morgan and S.J. Harders, QM W10970, 1♂; Daves Ck Country, Lamington Nat. Park, Mar 1976, QM W7252, 1♀; O'Reillys, Lamington Plateau, 16 Mar 1969, QM W3066, 1♂, 1♀; Best of All Lookout, Springbrook, 26 Dec 1973, QM W5092, 1♀; Creek near Tallanbana Entrance to Warrie Nat. Park, Springbrook, (28°14'S, 153°16'E), 3 May 1981, G.J. Morgan and S.J. Harders, QM W10974, 1♂, 2♀; Above Cameron Falls, Mt Tamborine, 5 Jun 1941, E.F. Riek, AM P11927, 7♂, 7♀; Cameron Falls and Witches Falls, Mt Tamborine, 16 Mar 1942, E.F. Riek, AM P11926, 14♂, 19♀; Cedar Ck, Joalah Nat. Park, Mt Tamborine, 1 May 1981, G.J. Morgan and S.J. Harders, QM W10971, 2 chelae; Upper Currumbin Ck, 1 Oct 1953, E.F. Riek, AM P13054, 1♀; Nerang R. near Nerang, 24 Jan 1973, QM W3835, 1♂; Levers Plateau via Rathdowney, 6 Oct 1973, QM W6462, 1♀; Border Tunnel, Running Ck and Mt Gipps, 14 Apr 1941, E.F. Riek?, AM P11925, 9♂, 7♀, 1♂/♀; Running Ck Falls, Qld-NSW border, near Kyogle, 12 Apr 1941, AM P13462, 2♂; Queen Marys Falls (at base), near Killarney, (28°20'S, 152°24'E), 27 Apr 1981, G.J. Morgan and S.J. Harders, QM W10969, 2♂; Tributary Cronan Ck, Mt Barney, (28°18'S, 152°42'E), 29 Apr 1981, G.J. Morgan and S.J. Harders, QM W10973, 2♂, 3♀; Ball Mt, Mt Superbus, 22-27 Jan 1971, S.R. Montieth, AM P19017, 1♀; Dollys Ck, Emu Vale, 22 Mar 1973, QM W7299, 1♀; Tarome, 12 Oct 1953, E.F. Riek, AM P13046, 1♂, 7♀; Head of Teviot Brook, near Cunninghams Gap, 26 Mar 1980, QM W8608, 1♂; Farm Ck, 6 km east of Mt Colliery, 22 Jun 1974, QM W5452, 1♂; Cunninghams Gap Nat. Park, near picnic area, 8 Jan 1972, QM W5080, 1♂; Western slopes of Cunninghams Gap, 23 Oct 1948, E.F. Riek, AM P11929-P11931, 3♂, 3♀, (types of *E. cunninghami* Riek); Tributary Gap Ck, Cunninghams Gap Nat. Park, (28°04'S, 152°23'E), 25 Apr 1981, G.J. Morgan and S.J. Harders, QM W10967, 3♂, 2♀; Gap Ck near 2nd picnic area, Cunninghams Gap Nat. Park, (28°04'S, 152°22'E), 26 Apr 1981, G.J. Morgan and S.J. Harders, QM W10968, 2♂, 1♀.

NSW. Brindle Ck, near picnic area, north of Kyogle, (28°22'S, 153°03'E), 28 Mar 1981, G.J. Morgan and S.J. Harders, AM P34107, 5♂, 2♀.

Diagnosis. Male cuticle partition present. Rostral spine row reaching proximal to midlength or full length of carinae. Rostral base parallel to very divergent, carinae of medium length to long. Antennal squame widest at, or proximal to, midlength. Squamal spines absent. Suborbital spine usually large or very large. Thoracic spines usually absent or just discernible. General tubercles small to medium-sized and dense (>40 OCL). 2-6 large or medium-sized Li spines on abdominal somite 2. D spine absent or small. Abdominal boss present (accented by colour). Telsonic surface spines absent or small. Marginal spines on uropods absent. Lateral propodal spines in 2 to 1 row condition (sometimes almost 2 rows). 3-11 dorsal apical propodal spines. Spines above propodal and dactylar cutting edges apical (row rarely extending to midlength of gape). Usually 5 mesal propodal spines. 1-4 dorsal mesal dactylar basal spines. 0-2 marginal mesal dactylar basal spines. 2-5 apical mesal dactylar spines. Dorsolongitudinal groove of carpus deep. 2-3 mesal carpal spines. Ventromesal carpal spines smaller than ventral spine. Keel Pr1 usually abrupt or semi-abrupt, and usually apart. TAP count 3.5-5.0.

Description. Maximum OCL 81.1 mm.

Rostrum: Rostrum reaching base or midlength of 3rd antennal segment on specimens >40 OCL, distal to midlength on some specimens 20-40 OCL, to end of segment on some specimens <20 OCL. Rostral sides parallel or slightly convergent on specimens from Lamington Plateau; in peripheral areas (Cunninghams Gap, northern New South Wales, Springbrook), sides often distinctly convergent. Rostral base parallel to very divergent. Carinae of medium length to long. Marginal spines numbering 3(very rarely 2) to 5 per side, row reaching proximal to midlength or to full carinae length; spines medium-sized on specimens >60 OCL, generally larger on smaller specimens; spines moderately pointed to sharp (rounded

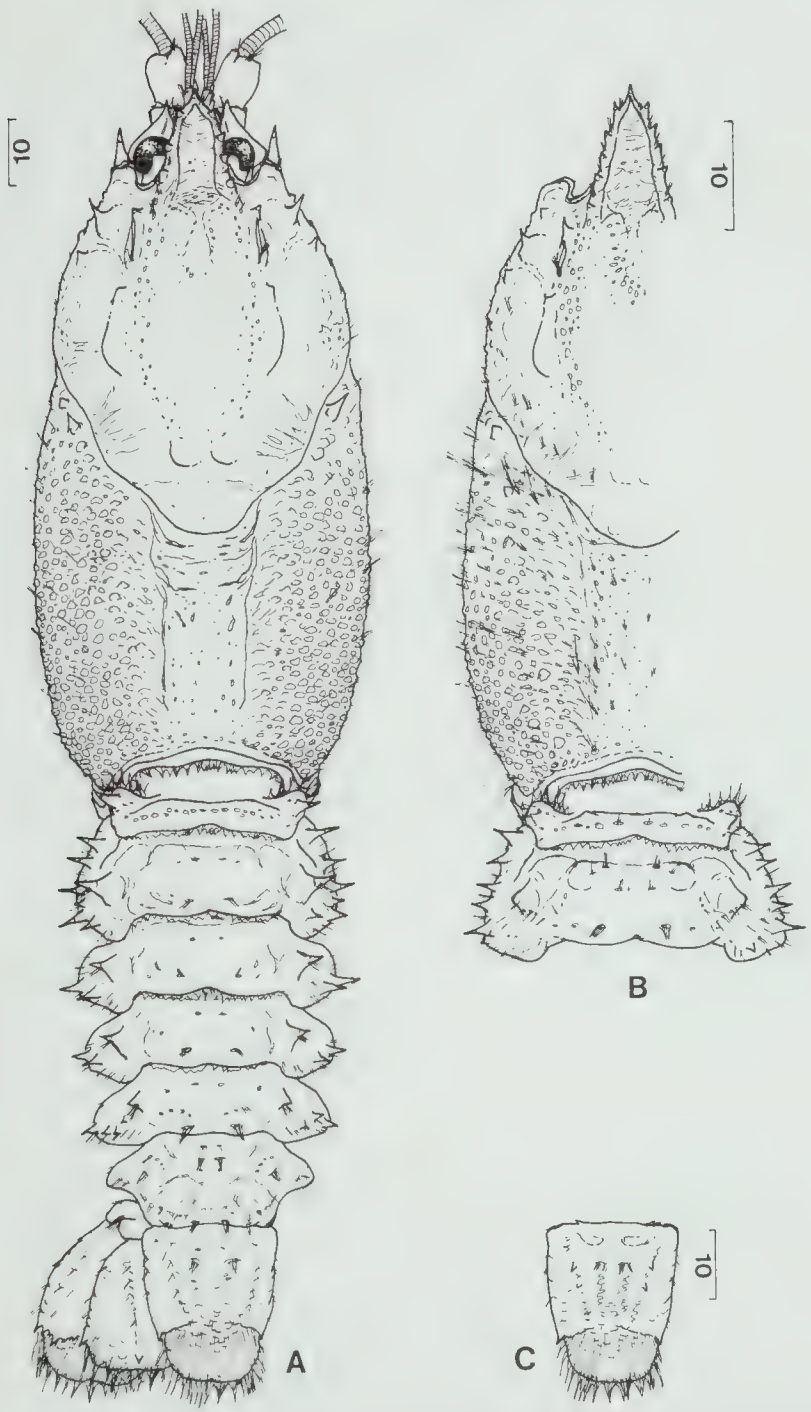

Figure 13. *Euastacus sulcatus*. A, dorsal view (holotype ♂, Binna Burra, AM P11921); B, dorsal view: larger rostral spines, smaller abdominal D-L spines, larger D spines including small spine on somite 1 (rare), more setose, wider abdomen (sexual) (♀, Cunninghams Gap, AM P11929, holotype for *E. cunninghami*); C, telson: small telsonic spines (♂, Brindle Ck, AM P34107).

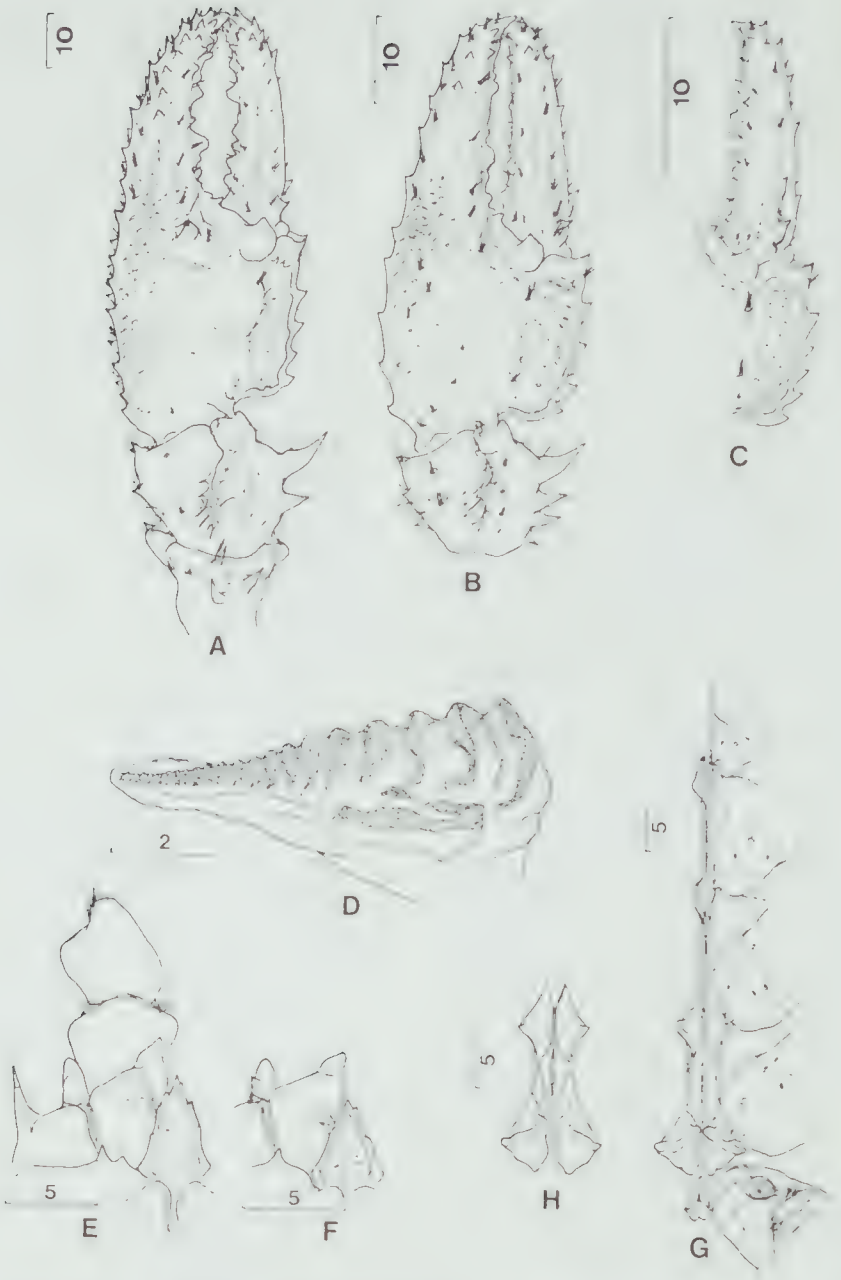

Figure 14. *Euastacus sulcatus*. A, dorsal view chela (holotype ♂); B, dorsal view chela: less angular, fewer apical spines on propodus and dactylus (allometry), no spine lateral to dactylar base, 3 mesal carpal spines (rare) (♀, Cunninghams Gap, AM P11931, paratype of *E. cunninghami*); C, dactylus and mesal propodus: 2 dorsal mesal dactylar basal spines, spines above cutting edge more spaced, 6 mesal propodal spines, extra dorsal apical dactylar spine absent (allometry) (♂, Mt Barney, QM W10973); D, zygocardiac ossicle (secondary ridge near ear rare) (paratype ♀, Binna Burra, AM P13030, Francois collection); E, ventral view cephalon (holotype ♂); F, ventral view cephalon: single cusp on coxopodite spine, larger basipodite spine, broader interantennal spine (♀, Cunninghams Gap); G, sternal keel (holotype ♂); H, keel processes 3 and 4 (♂, Brindle Ck).

on one medium-sized specimen, probably due to wear). Acumen spine similar to, or slightly larger than,marginal spines on specimens >40 OCL, much larger on some smaller crayfish.

OCL/CL 0.71-0.89 i. RW/OCL 0.14-0.25 d.

Cephalon: Cephalon spiny to poorly spinose, spination poor on most small specimens. Usually 1-3 large spines and smaller spines and bumps ventral to postorbital ridge. 1st postorbital spine usually medium-sized to large, rarely small. 2nd postorbital spine small edge to small on specimens >40 OCL, often medium or large on smaller animals. Suborbital spine usually large or very large, occasionally medium-sized. Lateral margin of squame slightly convex to slightly concave; squame widest at midlength or proximal to midlength on specimens >40 OCL, always proximal to midlength on smaller animals; marginal spines absent. Interantennal spine of medium width to broad on specimens >40 OCL, very broad on some smaller animals; spine margins distinctly scalloped or slightly to distinctly toothed. Antennal basipodite spine absent or small on specimens >60 OCL, absent to large on smaller specimens (very large on some <20 OCL); coxopodite spine small to medium-sized and unimodal, bifid or serrated.

ScL/OCL 0.12-0.35 d.

Thorax: Thoracic spines usually absent or just discernible; sometimes 1-3 small or medium-sized, blunt to moderately sharp spines behind cervical spines. General tubercles small to medium-sized on specimens >20 OCL, very small or absent on smaller animals; tubercles dense or very dense on specimens >40 OCL, sparse to dense on specimens 20-40 OCL and sparse to absent on animals <20 OCL. Usually 1-4 cervical spines per side, sometimes absent especially on smaller specimens; spines medium-sized or small and moderately pointed or blunt, dorsal spine frequently larger and sharper than others.

ArL/OCL 0.36-0.43. CaW/OCL 0.52-0.62. ArW/OCL 0.13-0.23 d. CaD/OCL 0.46-0.61 d.

Abdomen: D-L spine present or absent on somite 1 (specimens <20 OCL always lacking spine); spine large to tiny, smallest on small animals, and very sharp to blunt. D spine usually absent on somite 1, small or tiny and blunt when present. Somite 2 with 2-6 (usually 4 or 5) Li spines per side on most specimens >20 OCL; Li spines absent on most smaller animals . 1 Li spine on somites 3-5 of specimens >40 OCL and most 20-40 OCL. Li spines decreasing posteriorly from large to medium-sized or small on large specimens and medium-sized or small to tiny on small animals; spines sharp or very sharp on specimens >40 OCL, very sharp to blunt on smaller animals. Lii spines usually absent on somite 2, though 1-3 spines sometimes present. Somites 3-5 usually with 1-3 Lii spines, sometimes absent especially on small crayfish. Somite 6 with 0-2 Lii spines. Lii spines large to tiny, generally largest on somite 3 or 4, and decreasing to posterior ; spines on specimens 20-40 OCL small or tiny. Lii spines very sharp to blunt. Usually D-L spine on somites 2-5 of specimens >20 OCL and frequently on somite 6 of large specimens; D-L spine large to tiny, decreasing to posterior, and very sharp to blunt. D spine poorly developed, sometimes on somites 2-3 (rarely 4) of specimens >40 OCL, spine small or tiny and usually blunt or very blunt (rarely moderately pointed). D spine usually absent on specimens from Lamington and northern N.S.W., better developed in western areas of species' range. Specimens <20 OCL usually lacking abdominal spines. Abdominal dorsal boss present on specimens >40 OCL and on some smaller specimens; boss not very pronounced, though often accented by cream or white coloration.

AbdW/OCL ♂ 0.45-0.57, ♀ 0.45-0.64 i. OCL/L ♂ 0.32-0.45 i, ♀ 0.34-0.41 i.

Tailfan: Telsonic spines usually absent on specimens in Lamington area, more common in western areas and northern N.S.W. When present, spines tiny to small (rarely medium-sized) and numbering 1-5; specimens <40 OCL usually lacking telsonic spines. Lateral telsonic spines and uropod spines absent, though setal bumps developed. Standard spines usually small to medium-sized, large on some specimens <40 OCL.

TeL/OCL ♂ 0.30-0.45 d, ♀ 0.36-0.46.

Chelae: Chelae intermediate to elongate in shape on specimens >20 OCL, very elongate on some smaller animals. Teeth well developed on most specimens >40 OCL.

Propodus: Lateral propodal spines in 2 to 1 row condition, sometimes almost 2 rows; some regenerate chelae with 2 rows and some specimens <20 OCL with single lateral row. Lateral spines medium-sized or large and sharp. Outer spine ridge vague to obvious. Mesal propodal spines usually numbering 5, sometimes 4 or 6; some regenerate chelae with 7 spines. 3-11 dorsal apical propodal spines on specimens >60 OCL, 2-8 on specimens 40-60 OCL, 0-8 on animals 20-40 OCL, 0 on specimens <20 OCL. On large specimens, dorsal apical spine row often reaching proximal of dactylar base. 2-5 spines above cutting edge of specimens >60 OCL, 0-3 on smaller specimens; spines apical (row rarely extending to midlength of gape) and large to medium-sized on large animals, medium to small on small individuals; specimens <20 OCL lacking spines above cutting edge. Usually 1 medium to very large spine lateral to dactylar base dorsally, sometimes 2-3 spines or spines absent; spines often joining apical propodal spines. Usually some low bumps on outer spine ridge. Ventrally, 4-10 spines lateral to dactylar base, in row reaching distally along propodus on specimens >40 OCL from the Lamington area and northern N.S.W.; similarly sized animals from western areas (eg. Cunninghams Gap) usually with fewer spines (1-7); animals 20-40 OCL with 1-8 spines, most numerous on specimens in the Lamington area. Specimens <20 OCL sometimes lacking spines. Frequently 1 or 2 ventral apical propodal spines. Sometimes small spine posterior to dactylus, frequently only low ridge or bumps. Precarpal spines usually absent (some regenerate chelae with 1-2 small bumps).

PropL/OCL ♂ 0.78-1.02 i, ♀ 0.82-0.98. PropW/PropL 0.30-0.46 id. PropD/PropL 0.22-0.31.

Dactylus: 2(rarely 1)-4 apical spines above dactylar cutting edge on chelae of specimens >40 OCL, 0-3 spines on specimens 20-40 OCL, smaller specimens lacking spines; spines small to large. 1-5 extra dorsal dactylar spines on most specimens >40 OCL; regenerate chelae and specimens <40 OCL usually lacking extra dorsal

spines. 1-3(rarely 4) dorsal mesal dactylar basal spines, 0 on some regenerate chelae and specimens <20 OCL. 0-1 (rarely 2) marginal mesal dactylar basal spines, more frequently on specimens from areas peripheral to Lamington. Basal spines medium-sized to very large, usually rather sharp. 2-5 (usually 4) apical mesal dactylar spines. (Apical and basal mesal spines sometimes forming irregular row.) Dactylar groove shallow or distinct, deep on small specimens.

DactL/PropL 0.47-0.59(0.60).

Carpus: Dorsolongitudinal groove deep. Usually 2 or 2(+1) mesal carpal spines, occasionally 3 distinct spines. Distalmost spine largest and usually slightly more ventral than 2nd; 2nd and 3rd spines frequently contiguous at their bases. Lateral carpal spines medium-sized to large on specimens >40 OCL, small on some lesser individuals. Articulation spine usually absent on specimens >40 OCL, tiny to large on some smaller animals. Dorsal carpal spines absent except on some regenerate chelae. Ventral carpal spine large or very large (small on some very small animals). Largest ventromesal spine medium-sized to small with 1-3 smaller spines.

Merus: 7-12 dorsal meral spines. Outer meral spine medium-sized (rarely small) to large.

Keel: Pr1: Posterior margins usually abrupt to semi-abrupt (occasionally sloped). Ventral profiles slightly angled back, rounded, flat or angled down. Processes slightly to distinctly apart (close on one large specimen), usually parallel or closed in orientation. Keel after Pr1 occasionally with low, blunt spine.

Pr2: Usually open; if almost parallel, processes distinctly apart. Keel after Pr2 usually anteriorly pronounced, sometimes slightly saddle-shaped.

Pr3: Scoops absent or slight, bases sharp to rounded. keel after Pr3 usually saddle-shaped in Lamington area, posteriorly pronounced near Cunninghams Gap. Intermediate shapes common. Keel very pronounced on most specimens <40 OCL.

Pr4: Usually lacking or with only slight scoops, sharp to moderately rounded; anterior edges angular to very angular. Posterior profile usually irregular, sometimes straight or slightly convex.

Processes 3 and 4 narrow or just broad on specimens >40 OCL, often distinctly broad on smaller animals.

Setation: Light to rather heavy in east, western specimens more heavily setose.

Punctation: Dense or very dense, pores often faint on cephalon.

Gastric mill: TAP count 3.5-5.0; TAA count 1.0-1.5; spread 2.5-3.5 (rarely 4.0). Urocardiac ridges 7-11, increasing with specimen size.

Coloration: Body bright blue or blue/green dorsally on Lamington Plateau (L.P.) specimens, deep red in New South Wales, dark red/brown in west. Carapace paler ventrolaterally (often almost white on L.P.). Pale patches on dorsal cephalon. General tubercles and cephalic spines pale, often white. Rostral carinae pale. Abdominal dorsal boss often pale on large specimens, frequently white. Abdominal spines white. Carpus of cheliped blue on L.P., red in N.S.W., blue/green or green/brown in west; distal and lateral carpal edges often white; mesal spines blue or white. Propodus white laterally, often with dark mottling, grading to dark blue mesally on L.P.; red with white mottling in N.S.W.; blue/green or brown in west. Dactylus white with base blue on L.P.; base red in N.S.W.; base green in west. Fingers white or cream.

Body blue and white ventrally on L.P., orange and white in N.S.W., red and orange in west. Carpus of cheliped dark blue mesally and white laterally (or blue with lateral white patch) on L.P.; red in N.S.W.; blue/green mesally and orange laterally in west. Propodus primarily white with mesal blue area on L.P., white with red mesally in N.S.W., orange with green mesal edge in west. Lateral spines white. Fingers pale or white.

Colours of western crayfish often obscured by algae and debris attached to setae. Distinct blues and reds of adult crayfish (L.P., N.S.W.) poorly developed on specimens <30 OCL.

Sexes: Males possess a wide cuticle partition. A small male (OCL 26.8 mm) from Queen Marys Falls extruded spermatophores suggesting male sexual maturity at a small size.

Two of the females examined are mature near the upper limits of the 20-40 OCL range (OCLs of 38.9 and 39.3mm) and the latter is berried. This is rather a small maturation size for females of a relatively large species. However, the majority of females <40 OCL have unopen gonopores. Nine of 12 females 40-60 OCL and all females >60 OCL appear mature. It seems that female maturation usually occurs at OCLs of 40-60 mm.

Distribution and biology. The species inhabits mountains forming a crescent from Mt Tamborine to the Lamington Plateau in southern Queensland, west along the McPherson Range bordering New South Wales and north via Cunninghams Gap into the Mistake Mountains. Major drainage systems include the Nerang, Albert, Logan and possibly the Brisbane, Rivers flowing north and east, the Condamine River flowing west and the Richmond River in New South Wales. A relic population of *E. sulcatus* may persist on Mt Warning, drained by the Tweed River. *Euastacus sulcatus* appears restricted to streams bordered by rainforest or occasionally wet sclerophyll at altitudes exceeding 300 m a.s.l., rarely at lower elevations. The Nerang specimen was probably washed downstream during the seasonal heavy rains. Much of the natural vegetation has been cleared in the species' range and large stands of highland rainforest remain only in state forests and national parks. Females bear eggs over winter, with hatching probably in spring and summer. *Euastacus sulcatus* frequently has been observed walking overland from streams. A species of *Cherax* occurs in creeks at lower altitudes, the boundary between the two genera often closely correlating with the dry sclerophyll-rainforest ecotone.

Remarks. *Euastacus cunninghami* was described by Riek (1951) on the basis of specimens from only

the type locality of Cunninghams Gap. The species is here synonymised with *E. sulcatus* on the basis of morphologically intermediate populations from sites along the "Scenic Rim" of mountains partitioning Queensland and New South Wales. Even populations from the respective type localities are not distinguishable by Riek's diagnostic characters of setation, thoracic ornamentation and abdominal spination. Many of the apparent differences were probably due to comparison of animals of different sizes.

Euastacus sulcatus is a variable species. Frequently the carinae bases of southern forms are more nearly parallel than are those of specimens in the east. D abdominal spines are always small or absent, but usually better developed in the west. Telsonic spines are better developed in the western area than in the east, though spines are small or tiny when present. Dorsal apical propodal spines and ventral spines lateral to the dactylar base are more numerous in the eastern areas, though this is partly due to size effects. Marginal mesal dactylar basal spines are more common in western forms. The shapes of keel processes 3 and 4 vary considerably across the species' range, as does the profile of the keel between these processes. Setation is generally heavier in the west. Gastric mill TAP counts are usually higher in the east, due to longer zygocardiac ears.

The major variation within *E. sulcatus* is that of colour forms. Western populations are overall green/brown; the northern New South Wales population of Brindle Ck is distinctly red, while the Lamington and Springbrook populations are bright blue or blue/green. There is some variation from these three basic colour forms, but the colour patterns are very similar throughout the range of the species. In particular, the paler and white areas are similar in all populations.

It appears that the blue Lamington Plateau crayfish attain a greater size than those elsewhere. No specimens >60 OCL have been collected from western areas but sampling has not been intensive. The apparently larger sizes of eastern crayfish may be due in part to greater exposure of these animals to human observation and collecting.

Euastacus suttoni Clark

Figures 15, 16

Astacopsis serratus.—McCulloch, 1917: 237-238 (in part, Lyra near Stanthorpe, Qld, as locality).

Euastacus nobilis.—Clark, 1936: 15-17 (in part, Stanthorpe, Qld, as locality).

Euastacus suttoni Clark, 1941: 18-19, pl.5.—Clark and Burnet, 1942: 90-91.—Riek, 1951: 381.—Riek, 1969:895.

Material examined. Holotype. Qld, Wyberba(h), south Queensland, E. Sutton, NMV J877, ♀, OCL 86.3 mm.

Other specimens. Qld, Bald Rock Ck, Wyberba, 19 Nov 1952, QM W1835, 1♀; Girraween Nat. Park, south-east Queensland, Feb 1967, QM W5093, 1♀; Girraween Nat. Park, in creek in caves, 7 Dec 1971, QM W5081, 1♀; Glenalpin, 8 miles from Stanthorpe, tributary of Severn R., 1936, AM P11920, 1♀; Lyra, May 1912, W. Gawith, AM P3075-P3077, P3084, 3♂, 3♀.

NSW. Bald Rock Ck, Bald Rock Nat. Park, (28°51′S, 152°02′E), 31 Mar 1981, G.J. Morgan and S.J. Harders, AM P33888, 2♂, 3♀; Washpool Ck, near Thunderbolts Hideout, north of Tenterfield, (28°58′S, 152°04′E), 1 Apr 1981, G.J. Morgan and S.J. Harders, AM P33906, 3♂; Bluff R., New England Highway near Bluff Rock, (29°12′S, 152°01′E), 2 Apr 1981, G.J. Morgan and S.J. Harders, AM P33904, 4♂; Poverty Point, 3000 ft, 15 miles south-east of Tenterfield, Dec 1973, QM W6463, 1♂, 2♀; Scrubby Gully, headwaters of Highland Home Ck, 4 miles north-north-west of Torrington, New England District, AM P15535, 1♀; Deepwater R., 10 km upstream of New England Highway, Mar 1981, D. Dye, 1♂, 1♀; Deepwater R., near Ten Mile, east of Deepwater, (29°30′S, 152°04′E), 12 Apr 1981, G.J. Morgan and S.J. Harders, AM P33903, 4♂, 2♀; Severn R., near Dundee, north of Glen Innes, 1922, AM P5673, 1♂; Gibraltar Range Nat. Park, 9 Dec 1972, QM W6468, 1♀; Boundary Ck, Gibraltar Range Nat. Park, (29°33′S, 152°16′E), 2 Apr 1981, G.J. Morgan and S.J. Harders, AM P33907, 1♂; Dandahra Ck at junction with Waratah Ck, Gibraltar Range Nat. Park, (29°32′S, 152°19′E), 3 Apr 1981, G.J. Morgan and S.J. Harders, AM P33887, 1♂, 1♀; Swamp near Waratah Trig sign beside Gwydir Highway, Gibraltar Range Nat. Park, (29°30′S, 152°19′E), 3 Apr 1981, G.J. Morgan and S.J. Harders, AM P33890, 1♂, 2♀; Coombadja Ck, below Waratah Trig, Gibraltar Range Nat. Park,(29°30′S, 152°18′E), 3 Apr 1981, G.J. Morgan and S.J. Harders, AM P33905, 2♂, 3♀.

Diagnosis. Male cuticle partition present. Row of rostral marginal spines usually not reaching midlength of carinae. Rostral base slightly to very divergent, carinae of medium length to long. Antennal squame widest at or slightly proximal to midlength (>40 OCL). Squamal spines absent. Suborbital spine medium-sized to large. Thoracic spines medium-sized to large (>60 OCL). General tubercles medium-sized or large, moderate to sparse in density. 3-6 medium-sized or large Li spines on abdominal somite 2(>40 OCL). Medium-sized or small D spine usually present on somites 2-5 (>40 OCL), sometimes several on somite 6. Abdominal boss present but not obvious. 4-12 medium-sized to tiny telsonic surface spines (>40 OCL). Outer ramus of uropod lacking marginal spines. Lateral propodal spines in 2 to 1 row condition. Usually 1 dorsal apical propodal spine (variable). Spine rows above propodal and dactylar cutting edges not reaching midlength of gape. 5 (rarely 6) mesal

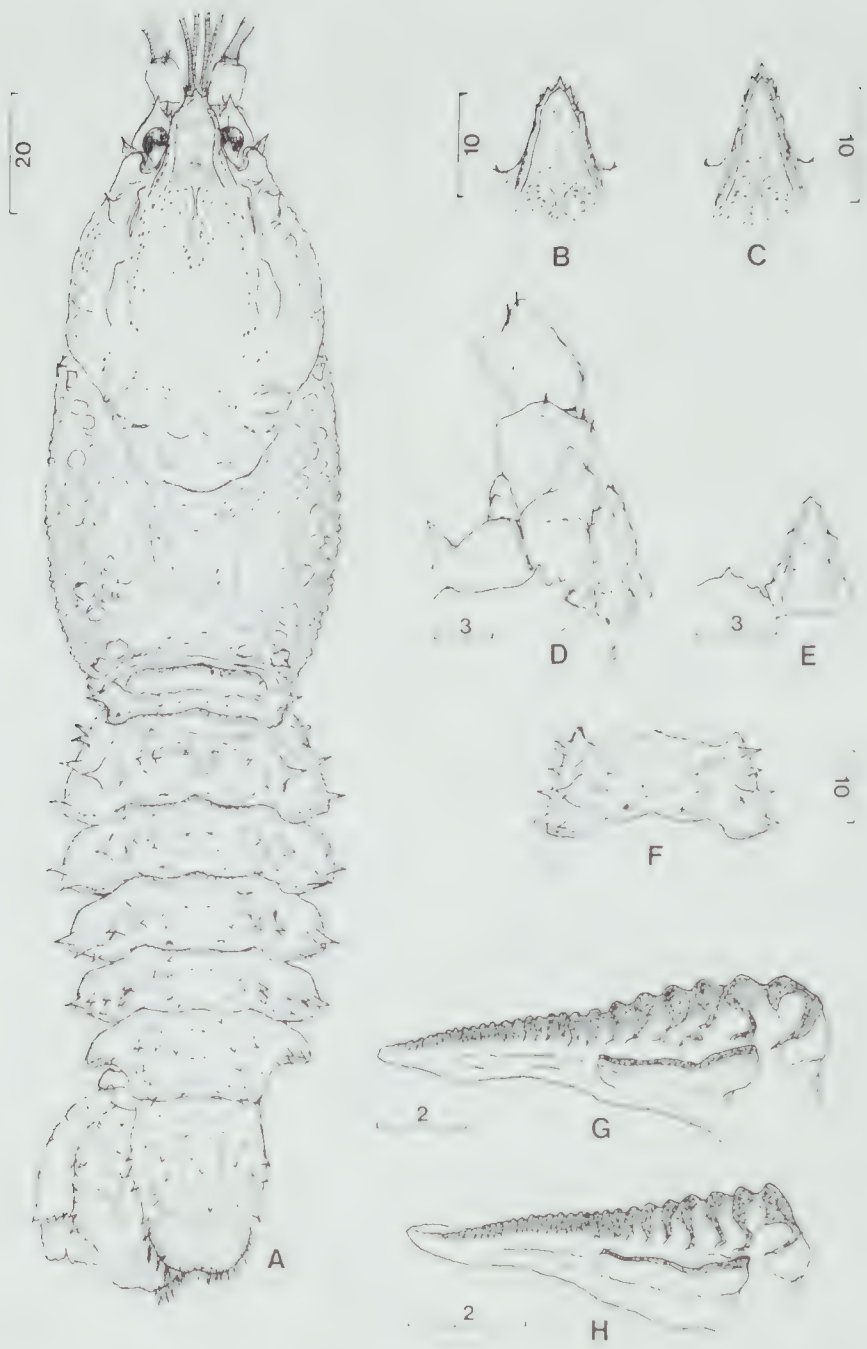

Figure 15. *Euastacus suttoni*. A, dorsal view (holotype ♀, Wyberba, NMV J877); B, rostrum (♀, Gibraltar Range, AM P33890); C, rostrum: more elongate (♀, Deepwater R., AM P34082); D, ventral view cephalon (holotype ♀); E, interantennal spine and coxopodite spines (♀, Deepwater R.); F, abdominal somite 2: more numerous L1 spines, single D spine per side, narrower (sexual) (♂, Gibraltar Range, AM P33890); G, zygocardiac ossicle (holotype ♀, Francois collection); H, zygocardiac ossicle: teeth closer (♂, Coombadja Ck, AM P33905).

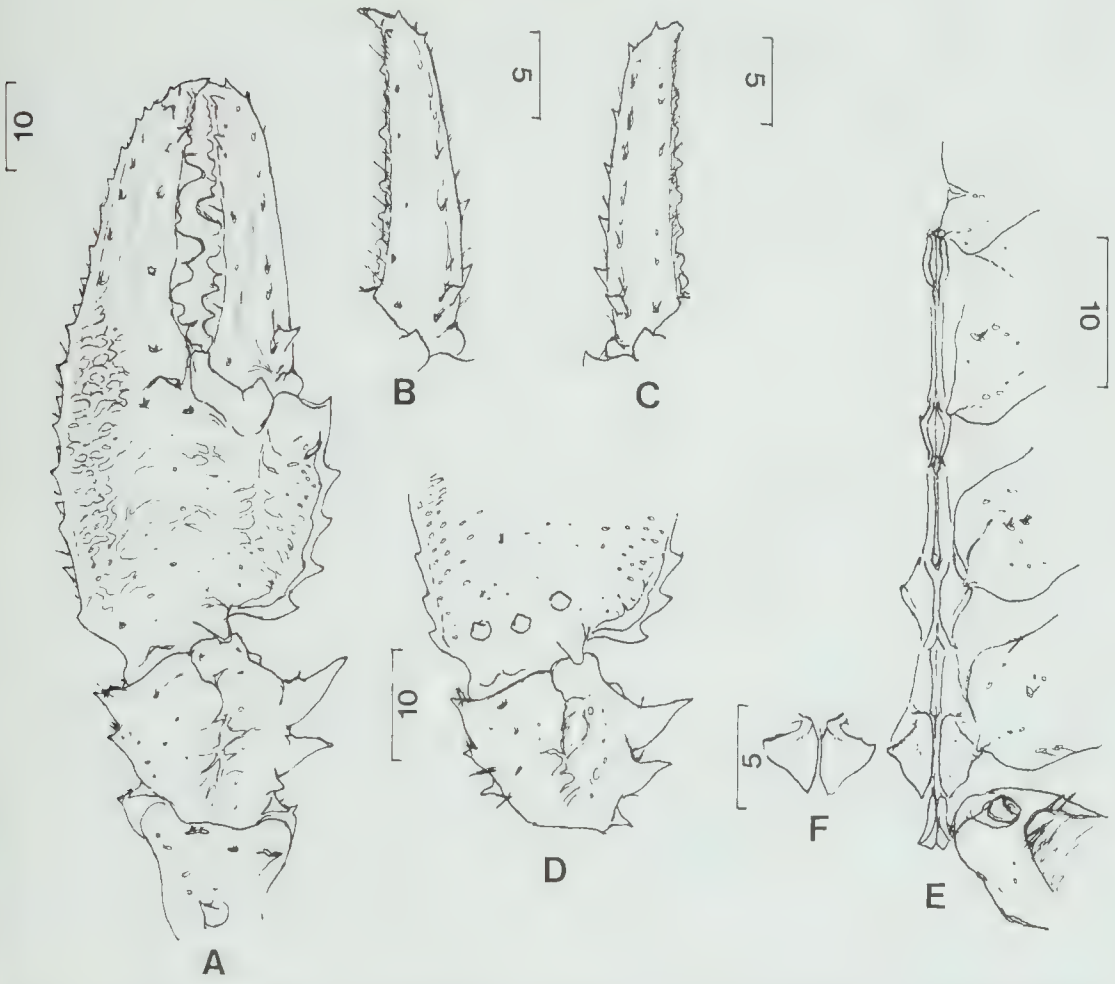

Figure 16. *Euastacus suttoni*. A, dorsal view chela (holotype ♀); B, dorsal view dactylus: 2 marginal mesal basal spines (♀, Deepwater R.); C, dactylus: row of marginal spines (regenerate) (♂, Deepwater R., AM P34082); D, carpus and proximal propodus: precarpal spines present, 3rd mesal carpal spine absent (♀, Gibraltar Range); E, sternal keel (♂, Gibraltar Range); F, keel Pr4: broader (allometry) (♀, Deepwater R.).

propodal spines. 1 dorsal mesal dactylar basal spine. 0-3 marginal mesal dactylar basal spines. 2-3 (rarely 4) apical mesal dactylar spines. Dorsolongitudinal groove of carpus deep. 2 (rarely 3) mesal carpal spines. Largest ventromesal carpal spine smaller than ventral spine. Keel Pr1 usually semi-abrupt and apart to close. TAP count 5.5-9.5.

Description. Maximum OCL 86.3 mm.

Rostrum: Rostrum reaching midlength of 3rd antennal segment on specimens >40 OCL, sometimes distal to midlength of segment on small crayfish. Rostral sides parallel to convergent, usually slightly convergent; base usually slightly to very divergent, sometimes parallel on small specimens. Carinae of medium length to long, not spread. 1-4 marginal spines per side (most commonly 2-3), row usually not reaching midlength of carinae, occasionally distal to midlength on specimens <20 OCL. Spines small to medium-sized and moderately pointed to rounded on specimens >40 OCL, approaching large and sharp on smaller crayfish, particularly those from southern areas. Acumen spine similar to, or slightly larger than, marginal spines on specimens >40 OCL, often much larger on smaller animals.

OCL/CL 0.76-0.88 i. RW/OCL 0.14-0.26 d.

Cephalon: Spination moderate to weak, with 1-3 sharp spines and smaller bumps below postorbital ridges. 1st postorbital spine an edge on specimens >60 OCL, usually medium-sized or large on smaller animals. 2nd postorbital spine a small edge to small on crayfish >20 OCL, medium-sized or large on some very small specimens. Suborbital spine medium-sized to large, usually slightly

curved inwards. Lateral margin of squame convex to straight; squame widest at or slightly proximal to midlength on specimens >40 OCL, very proximal on specimens <20 OCL; marginal spines absent (one specimen with spine on one squame only). Interantennal spine elongate on specimens >60 OCL, broader on smaller crayfish and sometimes very broad on animals <20 OCL; margin scalloped or slightly toothed (usually 2 small spines near apex). Antennal basipodite spine absent or small on specimens >40 OCL, often medium-sized or large on smaller specimens. Coxopodite spine usually medium to small, large on some animals <40 OCL, usually bifid or serrated.

ScL/OCL 0.12-0.31 d.

Thorax: Approximately 6-11 dorsal spines per side, distributed in zone or row on specimens >40 OCL; smaller specimens often with fewer spines. Crayfish <20 OCL usually lacking dorsal spines. Spines large to medium-sized on specimens >60 OCL, smaller on lesser crayfish; spines blunt to very sharp (not correlating closely with crayfish size). General tubercles large to medium-sized on specimens >60 OCL, smaller on smaller animals, crayfish <20 OCL often lacking general tubercles; density usually moderate to sparse. 1-3 cervical spines per side; spines small to large and blunt to sharp (dorsalmost spine usually larger and sharper than others).

ArL/OCL 0.33-0.38. CaW/OCL 0.55-0.62. ArW/OCL 0.13-0.21 d. CaD/OCL 0.49-0.56 d.

Abdomen: Somite 1 with moderate to sharp D-L spine on specimens >60 OCL and many smaller specimens, absent on animals <20 OCL. Rarely D spine on somite 1. Somite 2 with 3-6 Li spines per side on specimens >40 OCL, 0-4 on smaller crayfish; 1 Li spine on somites 3-5, except on some small animals; Li spines large to medium-sized and sharp to moderately pointed on crayfish >40 OCL, smaller and blunter on smaller crayfish. Lii spines well developed on somites 3-6, numbering 1-4 per side, higher numbers most commonly on somite 5 of large specimens; Lii spines large to small on specimens >40 OCL, tiny or absent on smaller specimens; spines very sharp on large specimens, blunter on small animals. 1 D-L spine usually on somites 2-3; sometimes 2 D-L spines per side on somites 4-6, particularly on specimens >60 OCL. D-L spines large to very small, very sharp to moderately pointed, often tiny and very blunt on specimens <40 OCL. D spines usually present on somites 2-5 of crayfish >40 OCL; D spines usually single but sometimes 4 per side on somite 5 of large crayfish. D spines poorly developed on somite 6, absent on specimens <60 OCL; D spines medium-sized to small on large crayfish, tiny on small specimens and very sharp to very blunt. Somite 6 rather spiny on large specimens, usually with several small D and D-L spines. Spinal development poor on crayfish <40 OCL, specimens <20 OCL usually lacking abdominal spines. Specimens from Deepwater with better development of D-L and D spines than similarly sized crayfish elsewhere. Low dorsal boss on very large specimens, very vague or absent on crayfish <80 OCL.

AbdW/OCL ♂ 0.48-0.56 d, ♀ 0.51-0.65 i. OCL/L 0.34-0.44 i.

Tailfan: Medium-sized to tiny surface spines on telson of specimens >40 OCL, often absent on smaller animals and never present on animals <20 OCL. Telsonic spines numbering 4-12, usually most numerous on large crayfish. Southern specimens (eg. from Gibraltar Range) usually with more spinose telsons than northern crayfish. Telson usually with 1-3 marginal spines per side, absent on most specimens <40 OCL. Inner ramus of uropod sometimes with 1-2 small to tiny surface spines (often absent). Usually 3-6 marginal spines on inner ramus of specimens >40 OCL, vague or absent below this size. Outer ramus lacking marginal spines, some bumps present. Standard spines small to medium-sized on crayfish >40 OCL, larger below this size.

TeL/OCL ♂ 0.31-0.46 d, ♀ 0.34-0.43 di.

Chelae: Chelae intermediate to elongate in shape, very elongate when regenerate or on specimens <20 OCL. Teeth well developed on crayfish >60 OCL.

Propodus: Lateral spines in 2 to 1 row condition, ventral row usually well developed but sometimes absent on very small crayfish and regenerate chelae. Lateral spines medium-sized or small, usually sharp. Usually 5 mesal propodal spines, sometimes 6 (3-6 spines on regenerate chelae, 4 on some very small crayfish). Usually 1 apical spine on crayfish >60 OCL, less evident or absent below this size (most Gibraltar Range specimens lacking apical spine, regardless of size). 1-3 spines above cutting edge of specimens >40 OCL, fewer or absent on smaller crayfish; spine row not reaching midlength of gape of chela, spines usually small (occasionally medium-sized). Dorsally, usually 1 medium-sized to large spine and low outer bumps lateral to dactylar base, spine occasionally absent especially on crayfish <20 OCL. Ventrally, 1-4 spines lateral to dactylar base; spines medium-sized on specimens >40 OCL, usually smaller on lesser specimens; spines often distributed some distance along finger. Sometimes low ridge or bumps proximal to dactylar base; often 1-3 precarpal spines, best developed on southern crayfish.

PropL/OCL (0.70)0.74-0.91 i. PropW/PropL 0.39-0.49 id. PropD/PropL 0.25-0.31.

Dactylus: Usually 1-2 spines above cutting edge of specimens >40 OCL (up to 4 spines on regenerate chelae); spine row not reaching midlength of gape (one aberrant specimen with 3 spines along full gape of one chela); spines small to medium-sized. Crayfish <40 OCL often lacking spines above cutting edge. No extra dorsal spines. 1 dorsal mesal basal spine (absent on some regenerate chelae). 0-3 marginal mesal basal spines, southern specimens often with more numerous marginal basal spines than those from Queensland. Basal spines large to medium-sized, usually sharp. 2-3 (rarely 4) apical dactylar spines. Dactylar groove shallow, or deep on some small crayfish.

DactL/PropL 0.51-0.60.

Carpus: Dorsolongitudinal groove deep. Usually 2 mesal carpal spines, sometimes 2(+1) (one large specimen with 3 on both carpi); distalmost spine largest and only slightly offset ventrally to 2nd. 2 large to medium (occasionally small) lateral carpal spines. Small articulation spine on specimens <60 OCL. 1-3 dorsal carpal spines on some specimens (usually absent). Ventral car-

pal spine very large to medium-sized. 1-3 ventromesl spines, largest medium-sized or small, always smaller than ventral spine.

Merus: 6-9 dorsal meral spines (occasionally more on regenerate chelae, fewer on some very small specimens). Outer meral spine absent or small to medium-sized on specimens >40 OCL, sometimes large on smaller crayfish.

Keel: Pr1: Posterior margins sloped on one large crayfish, usually semi-abrupt, abrupt on some specimens. Ventral profile angled, rounded or flat; processes close, slightly apart or apart; orientation usually parallel, sometimes closed. Keel after Pr1 sometimes with low bump or spine.

Pr2: Orientation almost parallel to open; processes projecting steeply from keel. Keel after Pr2 low or slightly pronounced, lacking definite spines.

Pr3: Lateral profiles sharp to moderate, lacking or with only very gradual scoop. Keel after Pr3 usually low or recessed on large crayfish, moderately pronounced on small specimens.

Pr4: Lateral profile sharp to moderate with scoops slight or absent; anterior margin very angular to angular; posterior margin convex to straight, sometimes irregular.

Processes 3 and 4 very narrow on specimens >40 OCL, broader on small crayfish.

Setation: Light.

Punctation: Moderate to dense.

Gastric mill: TAP count 5.5-9.5 (TAP counts partly correlate with increasing specimen size); TAA count 1.0 (rarely 0.5 or 1.5); spread 4.5-8.5 (largely determined by the TAP count). Zygocardiac ear shorter on small crayfish. Urocardiac ridges 8-12 (increasing with size).

Coloration: Body very dark red or green, often almost black dorsally, slightly paler ventrolaterally. Thoracic spines tipped with red or orange, often orange patches on lateral cephalon. General tubercles red or orange. Rostral spines red. L and D-L abdominal spines red, D spines often deep purple. Carpus and propodus of cheliped similar in colour to cephalothorax, propodus often crimson with green mottling laterally. Chela spines usually red. Finger tips orange or red.

Body red and orange ventrally, tinged in places with green. Carpus of cheliped very dark green mesally, red or orange laterally. Propodus bright red with mesal edge dark red/green and dark mottling basally. Fingers red.

Sexes: Males possess a cuticle partition, and mature at 20-40 OCL (spermatophores present).

Females develop open gonopores at 40-60 OCL; all >60 OCL are mature.

Distribution and biology. The known range of *E. suttoni* extends from the Stanthorpe area in southern Queensland, 120 km south along the Great Divide to Dundee near Glen Innes, and along the eastern spur of the Gibraltar Range. The species inhabits tributaries of the Severn and Dumaresque Rivers (Darling River system), draining to the west, and tributaries of the Clarence River to the east, occurring in streams and cold water swamps in predominantly granite country at elevations above 680 m a.s.l. (usually above 1000 m). Much of the range has been cleared for pasture but the natural vegetation of open sclerophyll and heath persists in places, especially along creeks and in national parks and state forests. *Euastacus suttoni* appears tolerant of clearing and grazing practices. Very small juveniles (<10 mm OCL) were found in April, indicating hatching only a few months earlier, possibly December or January. *Cherax* sp. was frequently collected downstream of *E. suttoni*.

Remarks. Euastacus suttoni is a rather invariable species, attributable in part to the fairly constant habitat across its range, without major geographical barriers. Southern specimens have slightly larger cervical and abdominal spines. Specimens from Gibraltar Range display slightly spinier telsons and uropods than northern populations, have a larger spine lateral to the dactylar base dorsally, generally lack a dorsal apical propodal spine and often possess more elongate chelae. Northern specimens (e.g., from the type locality near Stanthorpe and Bald Rock) have low TAP counts of 5.5-6.0 and spreads of 4.5-5.0. The teeth are closer and the ear longer in the south; dissected specimens from Bluff and Deepwater Rivers south of Tenterfield have TAP counts of 5.5-7.0 and spreads of 4.5-6.0. In the south-east of the species' range (Gibraltar Range), TAP counts are 7.5-9.0 and spreads are 6.5-8.5. This variation represents a distinct cline in tooth counts.

The cephalothoracic background colour of northern specimens is less distinctly deep red/black, being more a deep olive green, than southern crayfish.

Euastacus valentulus Riek

Figures 17, 18

Potamobius serratus—White, 1850: 96 (in part, Richmond R. as locality?).

Euastacus valentulus Riek, 1951: 380.—Riek, 1956: 1.—Riek, 1969: 896, figs 16E, 20A-D, H-J.

Material examined. Allotype: Qld, upper reaches of Currumbin Creek, southeast Queensland, 1 Oct 1953, E.F. Riek, AM P13038, ♀, OCL 49.4 mm.

Other specimens: Qld. Upper reaches of Currumbin Ck, 1 Oct 1953, E.F. Riek, AM P13037, 7♂, 3F; Upper Currumbin Ck, (28°14'S, 153°22'E), 5 May 1981, G.J. Morgan and S.J. Harders, QM W10975, 1♂ and a chela.

NSW. Teven Ck, 2 miles from Teven near Ballina, 28 Sep 1954, A. Racek, AM P15521, 1♀; Stream below Victoria Park, inland from Ballina, 8 Oct 1962, JCY, AM P14623, 1♂, 1♀; Minyan Falls near Rosebank, Lismore area, 11 Jan 1958, E.F. Riek, AM P15730, 2♂, 1♀; Wil-

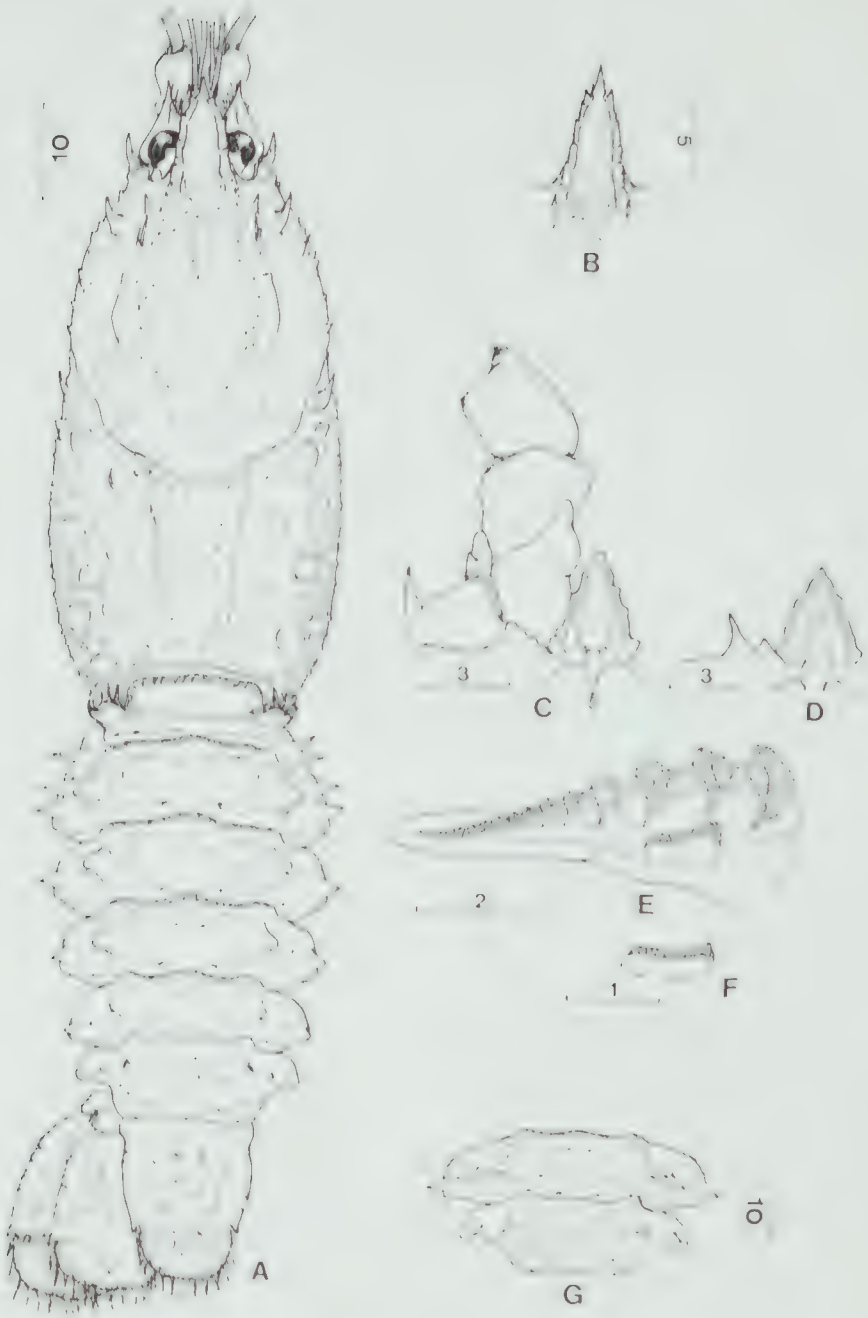

Figure 17. *Euastacus valentulus*. A, dorsal view (allotype ♀, Currumbin Ck, AM P13038); B, rostrum: more numerous spines, more elongate (allometry) (♀, Minyan Falls, AM P15730); C, ventral cephalon (allotype ♀); D, interantennal and bifid coxopodite spines (♀, Korrumbyn Ck, AM P33912); E, zygocardiac ossicle (allotype ♀, Francois collection); F, zygocardiac ear: slightly longer (♂, Brunswick R., AM P33918); G, abdominal somites 5 and 6: larger spines (allometry) (♀, Wilsons Ck).

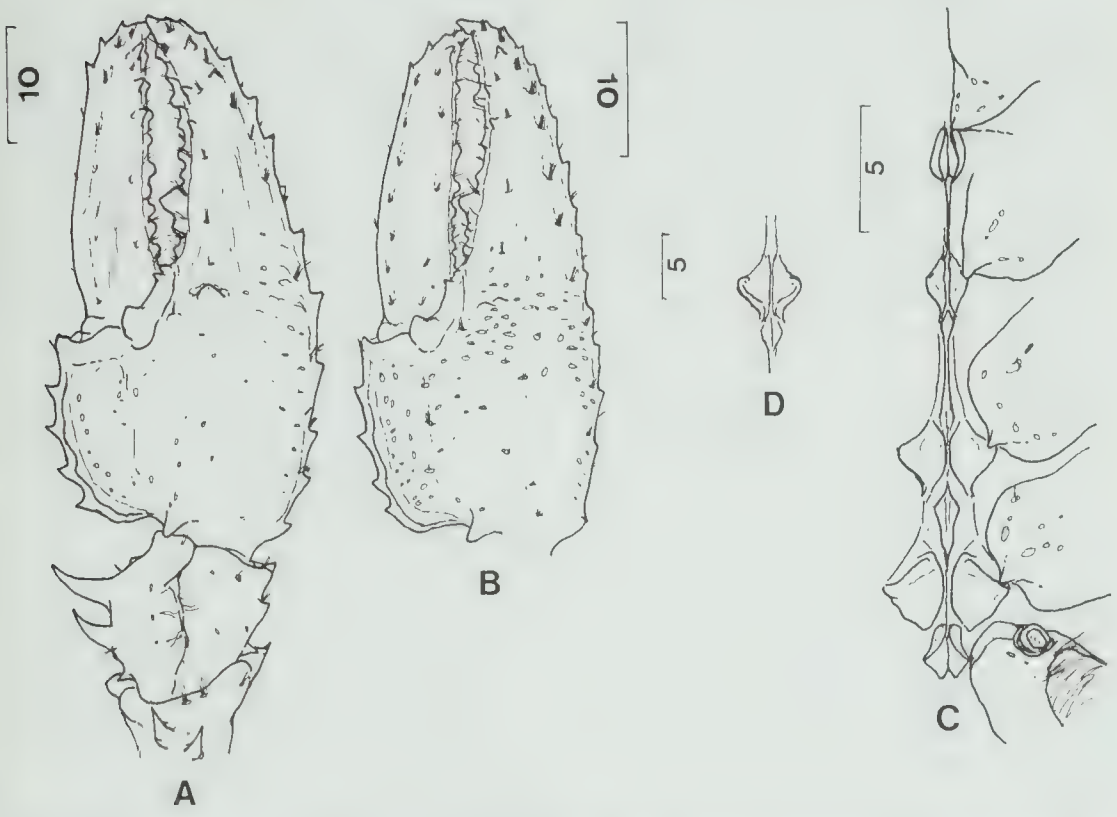

Figure 18. *Euastacus valentulus*. A, dorsal view chela (allotype ♀); B, chela: more elongate, 1 apical propodal spine, fewer spines above dactylar cutting edge, spine lateral to dactylar base very small (all largely allometry) (♂, Minyon Falls, AM P15730); C, sternal keel (♂, Brunswick R.); D, keel Pr2: broad, very open (♀, Wilsons Ck).

sons Ck, south of Mullumbimby, Sep 1980, R. Wilesmith, 1♂, 1♀; Wilsons Ck, south of Mullumbimby, (28°38′S, 153°28′E), 2-4 Sep 1981, G.J. Morgan and S.J. Harders, 2♂; Doon Doon Ck, 28 Jun 1979, 2♂; Mt Warning, 26 Mar 1967, QM W2861, 1♀; Korrumbyn Ck, foot of Mt Warning, (28°24′S, 153°19′E), 25 Mar 1981, G.J. Morgan and S.J. Harders, AM P33912, 1♂, 1♀; Back Ck, Unumgar State Forest, (28°26′S, 152°43′E), 29-30 Mar 1981, G.J. Morgan and S.J. Harders, AM P33914, 1♂, 4♀; Boomi Ck, Edinburgh State Forest, (28°27′S, 152°39′E), 30 Mar 1981, G.J. Morgan and S.J. Harders, AM P33911, 1♀; Couchy Ck, north of Chillingham, (28°17′S, 153°16′E), 4 May 1981, G.J. Morgan and S.J. Harders, AM P33909, 1♂, 1♀; Upper Brunswick R., near Nullum State Forest, (28°29′S, 153°24′E), 2 Sep 1981, G.J. Morgan and S.J. Harders, AM P33918, 1♂, 1♀; Rocky Ck, Whian Whian State Forest, (28°36′S, 153°21′E), 5 Sep 1981, G.J. Morgan and S.J. Harders, AM P33917, 1♀; Tributary Rocky Ck, Whian Whian S.F., (28°34′S, 153°20′E), 5 Sep 1981, G.J. Morgan and S.J. Harders, AM P33910, 1♂.

Diagnosis. Male cuticle partition present. Rostral marginal spine row reaching proximal to midlength of carinae. Rostral base divergent, carinae of medium length to long. Antennal squame widest at slightly or distinctly proximal to midlength. Squamal spines absent. Suborbital spine large or very large. Thoracic spines large (>40 OCL). General tubercles large or medium-sized, moderate to sparse in density. 2-4 large Li spines on abdominal somite 2. D Abdominal spine usually absent. Abdominal boss poorly developed. Usually 2-5 small or tiny telsonic surface spines, sometimes absent. Uropod lacking spines. Lateral propodal spines in 2 to 1 row condition. 1-3 dorsal apical propodal spines. Spines above propodal and dactylar cutting edges usually apical. Usually 5 mesal propodal spines. Dorsal and marginal mesal dactylar basal spines absent. 3-4 apical mesal dactylar spines. Dorsolongitudinal groove of carpus deep. 2 (rarely 3) mesal carpal spines. Ventromesal carpal spines much smaller than ventral spine. Keel Pr1 semi-abrupt to sloped, and apart. TAP count 2.5-3.5.

Description. Maximum OCL: 91.1 mm.

Rostrum: Rostrum broad, reaching beyond base,sometimes beyond midlength, of 3rd antennal segment; some specimens <40 OCL with rostrum reaching to end or distal to end of segment. Rostral sides parallel or slightly convergent; base slightly to distinctly divergent, carinae of medium length to long. Marginal spines numbering 3-6 per side, in row reaching proximal to midlength or almost full length of carinae; spines medium-sized to large, usually moderately pointed to sharp (one very large specimen with rounded spines, probably due to abrasion). Acumen spine slightly to much larger than marginal spines on specimens >40 OCL, very much larger on most smaller specimens.

OCL/CL 0.72-0.85 i. RW/OCL 0.16-0.23 d.

Cephalon: Cephalon moderately spiny to very spiny on specimens >20 OCL, some very small crayfish poorly spinose; usually 1 or 2 large spines and smaller bumps ventral to postorbital ridges. 1st postorbital spine medium-sized to large, very large on some specimens <20 OCL. 2nd postorbital spine a small edge on specimens >40 OCL, medium or large on some smaller specimens. Suborbital spine large or very large and obviously curved inwards. Lateral margin of antennal squame convex to slightly concave; squame widest slightly proximal to midlength on largest specimen, distinctly proximal on most specimens and very proximal on some small crayfish; marginal spines absent. Interantennal spine broad, very broad on some specimens <20 OCL; margin scalloped or toothed. Antennal basipodite spine small to medium-sized on specimens >40 OCL, large or very large on most smaller specimens; coxopodite spine small to medium-sized on specimens >60 OCL, small to large on lesser specimens and usually weakly bifid or slightly serrated.

ScL/OCL 0.15-0.33 d.

Thorax: Approximately 5-13 thoracic spines per side except on some very small specimens lacking spines. Spines large on specimens >40 OCL, medium-sized to small on lesser crayfish; sharp to blunt spines on most specimens (dorsal spines often broad and flat); spines blunter on smaller animals and usually rounded or flat when present on specimens <20 OCL. Spines arranged in zone or approximately 2 rows. General tubercles large to medium-sized on specimens >20 OCL, small or very small on specimens <20 OCL, absent on smallest individuals; tubercle density moderate to sparse on specimens >20 OCL, sparse to very sparse on smaller animals. 1-2 (rarely 3) cervical spines, dorsalmost usually large or very large and sharp, 2nd medium or small.

ArL/OCL 0.36-0.41; ArW/OCL 0.15-0.21 d; CaW/OCL 0.56-0.68 i; CaD/OCL 0.50-0.57 d.

Abdomen: D-L spine on somite 1 of specimens >40 OCL and most specimens 20-40 OCL, absent on smaller crayfish; spine very large or large on specimens >60 OCL, usually medium-sized or small on lesser animals, and very sharp on specimens >60 OCL, sharp or moderately pointed on smaller crayfish. D spine absent on somite 1 (largest specimen with bumps in D position). On somite 2, 3-4 Li spines per side on specimens >40 OCL, 2 (rarely 1)-4 on smaller specimens, 0 spines on specimens <20 OCL. Li spine on somites 3-5 of specimens >20 OCL, absent on smaller crayfish. Li spines decreasing in size posteriorly, very large to large or medium-sized on specimens >60 OCL, large to medium or small on specimens 40-60 OCL and medium to small or tiny on smaller animals; spines very sharp to moderate on specimens >40 OCL, sharp to blunt on specimens 20-40 OCL. Lii spines absent on somites 2 and 3, sometimes present on somites 4 and 5, and 1 or 2 Lii spines present on somite 6 of specimens >20 OCL; Lii spines large to medium-sized and very sharp on largest specimen, medium-sized to tiny and moderately pointed to blunt on others. D-L spine on somite 2 of most specimens >20 OCL (absent on smaller specimens in 20-40 OCL range); spine present on subsequent somites of specimens >40 OCL and many smaller specimens (one specimen with 2 small D-L spines on somite 6). D-L spines very large to small and very sharp on specimens >60 OCL, large to tiny and sharp to blunt on crayfish 40-60 OCL, medium-sized to tiny and moderate to very blunt on smaller specimens. D spine usually absent, but some specimens of all sizes with small to tiny and very blunt spine on some somites. Low dorsal abdominal boss on some specimens >60 OCL, vague or absent on smaller animals.

AbdW/OCL ♂ 0.49-0.56 i, ♀ 0.52-0.64 i; OCL/L 0.34-0.41 i.

Tailfan: Usually 2-5 very small or tiny telsonic surface spines on specimens >20 OCL, though largest specimen lacking spines. Marginal spines on telson and uropods absent, outer margins of uropods merely bumpy. Standard spines medium-sized to large.

TeL/OCL 0.34-0.41 d.

Chelae: Chelae elongate to stout. Teeth well developed on specimens >60 OCL.

Propodus: Lateral propodal spines in 2 to 1 row condition, ventral row often poorly developed on specimens of all sizes; some regenerate chelae and specimens <20 OCL with only dorsal propodal row. Lateral spines small or medium-sized and sharp on specimens >60 OCL, large on some smaller specimens. Lateral spine ridge vague or absent. Usually 5 mesal propodal spines; some regenerate chelae and some specimens <40 OCL with 4 or 6 spines. 3 dorsal apical spines on specimens >60 OCL, 1-3 on most specimens 20-60 OCL; some chelae (especially regenerate and on specimens <20 OCL) lacking apical spines. 2-3 spines above cutting edge of propodus on specimens >60 OCL, usually 1-3 on specimens 20-40 OCL, some specimens slightly >20 OCL and all <20 OCL lacking spines; spines usually apical, rarely in row reaching to midlength of gape; spines usually large and moderately pointed or sharp, small on most specimens <40 OCL. Usually 1 or 2 small, blunt spines lateral to dactylar base dorsally, though spines sometimes absent and two small specimens with 3 and 5 small spines. Very poor development of bumps on lateral ridge. Ventrally, usually 1 or 2 small or medium (rarely large) spines lateral to dactylar base (one specimen with 5 spines on one chela). Spines absent proximal to dactylar articulation, very low ridge sometimes present. Precarpal spines absent.

PropL/OCL ♂ 0.86-0.99, ♀ (0.82)0.89-0.97; PropW/PropL 0.35-0.48 id; PropD/PropL 0.22-0.30 id.

Dactylus: 2-3 spines above dactylar cutting edge of specimens >40 OCL, 1-3 (sometimes 0) on specimens 20-40 OCL, 0 spines on some regenerate chelae and specimens <20 OCL; spines apical and very large to medium-sized on specimens >40 OCL, small on many specimens <40 OCL. Extra dorsal dactylar spines absent. Dorsal and marginal mesal dactylar basal spines absent. 3-4 apical mesal dactylar spines (one medium-sized specimen with 2 apical spines and bump on one dactylus); some specimens <20 OCL with 2 spines on one chela, one specimen with regenerate chela with 5 apical spines. Dactylar groove absent on specimens >60 OCL, vague or shallow on smaller animals.

DactL/PropL 0.49-0.60.

Carpus: Dorsolongitudinal groove deep. Usually 2 mesal carpal spines, sometimes bump or small spine proximal to 2nd; one small specimen with 3 distinct spines on one carpus and 2(+1) on other. Distalmost spine much larger than, and distinctly offset ventrally to, 2nd. 2 lateral carpal spines (1 spine on one specimen); lateral spines usually medium-sized, sometimes large or small. Articulation spine absent except on some <40 OCL with small or medium spine. Dorsal carpal spines usually absent though some specimens <40 OCL with small spine or low bump. Ventral carpal spine very large or large. 1-2 ventromesal spines, largest medium-small to tiny (much smaller than ventral spine).

Merus: Usually 6-8 dorsal meral spines. Outer meral spine usually large, occasionally medium-sized.

Keel: Pr1: Posterior margins semi-abrupt to sloped; ventral profiles flat, rounded or slightly angled down or back; processes apart or very apart and either closed or parallel in orientation. Keel after Pr1 usually slightly pronounced anteriorly, sometimes anterior spine present.

Pr2: Open or very open. Keel after Pr2 slightly or distinctly pronounced.

Pr3: Usually slight or gradual scoops and moderate to rounded bases; occasional specimens lacking scoops. Keel after Pr3 moderately pronounced on large specimens, distinctly pronounced on smaller animals.

Pr4: Scoops developed on largest specimen, but usually only slight or absent; bases rounded to moderate, sharper on some specimens <40 OCL, and posterior margins straight, irregular or slightly convex; anterior edges angular or very angular (ridged).

Processes 3 and 4 broad, very broad on small specimens.

Setation: Light.

Punctation: Moderately dense on large animals, dense on small specimens.

Gastric mill: TAP count 2.5-3.0 (rarely 3.5); TAA count 1.0-1.5; spread 1.0-2.0. Teeth large and rather spaced; zygocardiac ear relatively short. Urocardiac ridges 5-8.

Coloration: Body dark green, green/brown or green/blue (occasionally red/brown) dorsally, paler ventrolaterally. Thoracic spines dark green or black. General tubercles pale brown. Posterior margins of abdominal somites darker than anterior. L abdominal spines often yellow or orange with black tips; D-L and D spines dark. Carpus and propodus of cheliped blue/green. Propodal lateral spines white, mesal spines orange. Dactylus blue or blue/green. Fingertips pale yellow.

Body red, green, orange and yellow ventrally, sometimes with white and blue patches. Carpus of cheliped blue or blue/green, sometimes yellow laterally; ventral spine sometimes orange. Propodus blue with dark mesal edge, an orange patch near articulation with dactylus. Dactylus blue.

Small crayfish green or brown, with patches of yellow.

Sexes: Males possess a cuticle partition. One female in the 40-60 OCL range is berried and another has gonopores that appear to be opening. The one female in the 60-80 OCL range has closed gonopores, but those of the specimen >80 OCL are open and it is likely that most females mature in the 40-80 OCL range.

Distribution and biology. The species ranges from upper Currumbin Ck west of the Gold Coast, southeast Queensland, south to the Ballina area of New South Wales, a distance of approximately 90 km, and from coastal northern NSW west to the Woodenbong area, approximately 100 km. *Euastacus valentulus* is present in the Tweed, Richmond and upper Clarence systems, as well as in some smaller coastal streams where the terrain is hilly and the species ranges into mountain forest to elevations of 600 m. Natural vegetation in its range is largely coastal rainforest and wet sclerophyll forest but most has been cleared for agriculture. *Euastacus valentulus* is not confined to forested areas but prefers streams retaining some natural growth along the banks. Females bear eggs in winter which usually hatch in October-November.

Euastacus valentulus and *E. sulcatus* cohabit many streams, the former at lower altitudes. A species of *Cherax* is occasionally sympatric with *E. valentulus* but usually occurs farther downstream.

Remarks. The species does not show marked clinal character variation over its range and specimens from southeast Queensland are very similar to those from the Lismore-Ballina area of New South Wales. Most specimens examined were in the 20-40 OCL range and only limited numbers of larger animals are present in collections.

The holotype of *E. valentulus* was lodged in the Queensland Museum but appears to be lost (fide Riek, 1969: 896) and could not be found for this study.

Euastacus setosus (Riek)

Figures 19, 20

Euastacoides setosus Riek, 1956: 4-5.—Riek, 1969: 897.—Riek, 1972: 374, fig. 12.

Material examined. Holotype: Qld, Mt Glorious, 4 Nov 1953, E.F. Riek, AM P12887, ♂, OCL 27.4 mm.

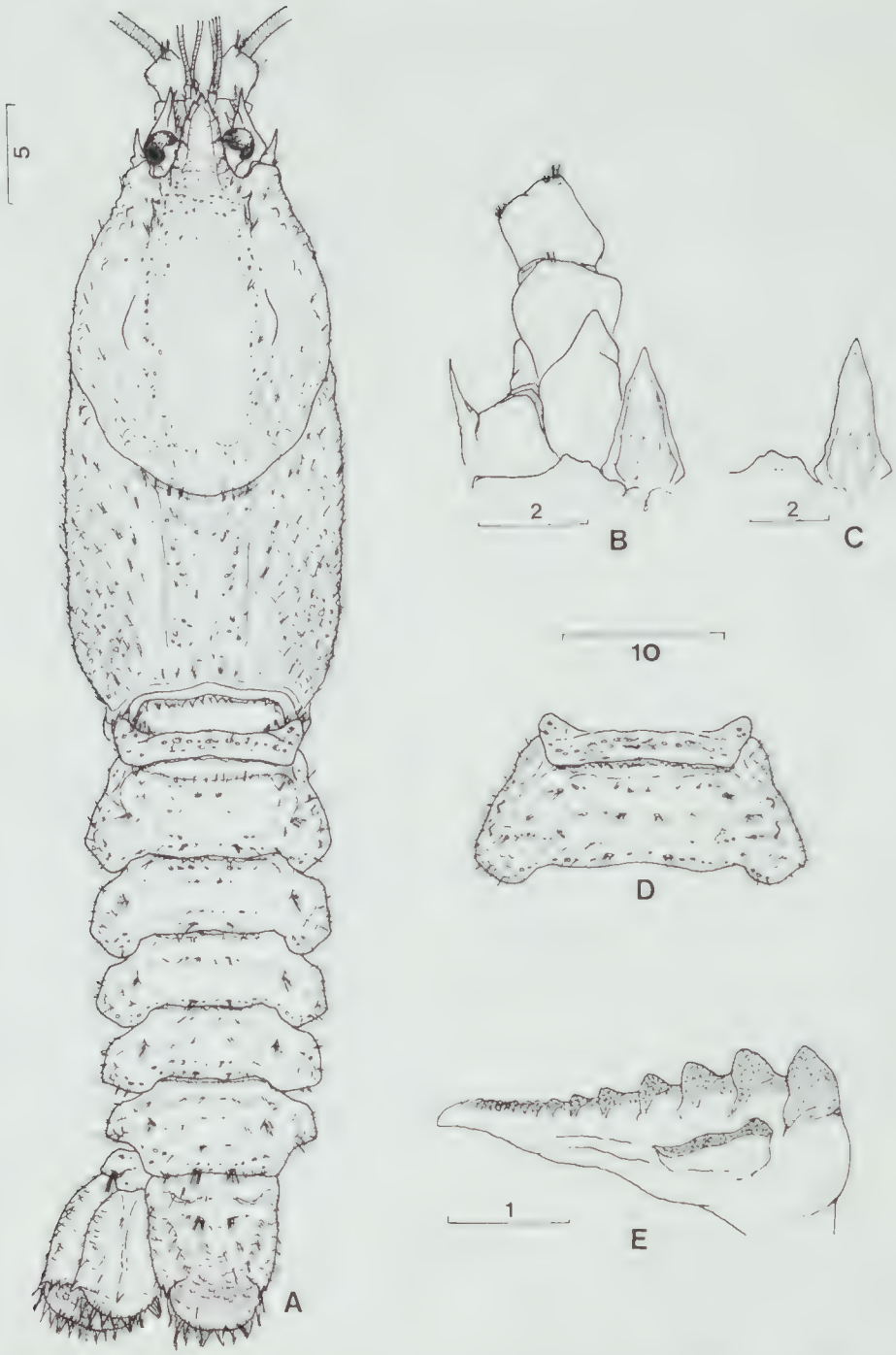

Figure 19. *Euastacus setosus*. A, dorsal view (holotype ♂, Mt Glorious, AM P12887); B, ventral view cephalon (holotype ♂); C, elongate interantennal spine (♂, Maiala Nat. Park, QM W10960); D, abdominal somites 1 and 2: Li spines slightly better developed, abdomen broader (sexual) (♀, Maiala Nat. Park, QM W10960); E, zygocardiac ossicle (holotype ♂, Francois collection).

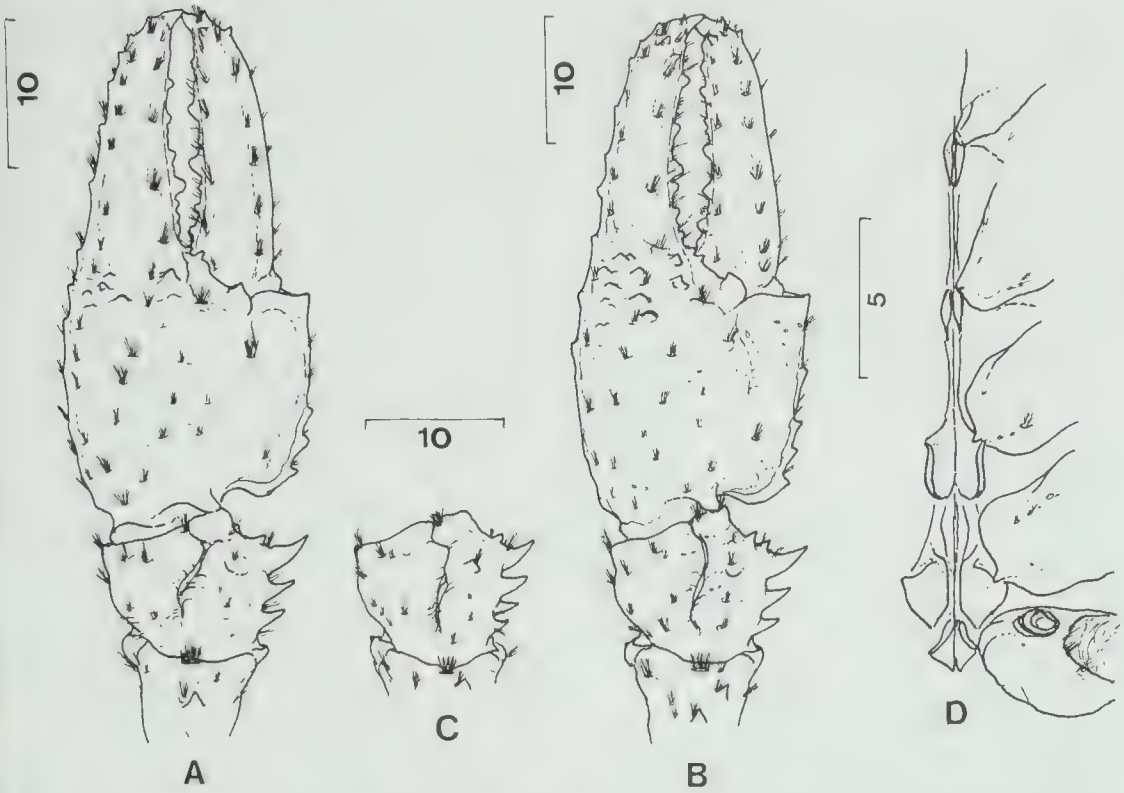

Figure 20. *Euastacus setosus*. A, dorsal view chela (holotype ♂); B, chela: dorsal apical propodal spine present, 5 mesal propodal spines, 2 small distal mesal carpal spines (♂, Maiala Nat. Park); C, carpus: 4 large mesal spines (+1 distal) (allotype ♀, Mt Glorious, AM P12887); D, sternal keel (holotype ♂).

Allotype: Type locality, AM P12887, ♀, OCL 31.8mm.

Paratypes: Qld, type locality AM P12823, 23 specimens.

Other specimens: Qld, Mt Glorious near Greens Falls, Maiala National Park, 12 Apr 1972, QM W5082, 1♂; Mt Glorious, 18 Jul 1943, E.F. Riek(?), AM P11928, 1♀; Tributary Cedar Ck, Maiala N.P. near Mt Glorious, (27°20'S, 152°46'E), 5 Oct 1982, G.J. Morgan and S.J. Harders, QM W10960, 5♂, 4♀.

Diagnosis. Male cuticle partition present. Rostral marginal spine row reaching proximal to midlength or full length of carinae. Rostral base divergent or very divergent, carinae short and spread. Antennal squame widest very proximal to midlength. Squamal spines absent. Suborbital spine large or very large. Thoracic spines absent. General tubercles small or very small, and rather dense to sparse. Li abdominal spines reduced to small bumps. D spines and abdominal boss absent. Tailfan spines absent. Ventral lateral propodal spine row absent. Dorsal apical propodal spines usually absent (rarely 1). Usually 1 apical spine above propodal and dactylar cutting edges. Usually 4 mesal propodal spines. Dorsal and marginal mesal dactylar basal spines absent. 2 apical mesal dactylar spines. Dorsolongitudinal groove of carpus deep. Usually 4-5 mesal carpal spines. Largest ventromesal carpal spine larger than ventral spine. Keel Pr1 abrupt or semi-abrupt, and close. TAP count 3.5 (rarely 3.0).

Description. Maximum OCL: 38.5 mm.

Rostrum: Rostrum very short, reaching base of 3rd antennal segment only on some specimens <20 OCL. Rostral sides convergent or slightly convergent, almost parallel on some very small specimens. Rostral base divergent or very divergent, carinae short and spread. 3(rarely 2)-5 rostral spines per side, in row reaching proximal to midlength or full length of carinae; spines medium-sized or small, moderately pointed to sharp. Acumen spine similar in size to marginals.

OCL/CL 0.84-0.88 i; RW/OCL 0.13-0.18 d.

Cephalon: Cephalon spiny to moderately spiny on specimens >20 OCL, poorly spinose on smaller animals, with several small spines (usually 1 slightly larger) ventral to postorbital ridges. 1st postorbital spine small to medium-sized; 2nd postorbital spine absent. Suborbital spine large or very large. Lateral margin of squame usually

slightly concave, sometimes approximately straight; squame widest very proximal to midlength, slightly proximal on some very small specimens; marginal spines absent. Interantennal spine elongate to medium in width on specimens >20 OCL, medium to broad on smaller crayfish; margins straight or slightly serrated. Antennal basipodite spine absent; coxopodite spine small or tiny and unimodal, weakly bifid, or slightly serrated.

ScL/OCL 0.14-0.21 d.

Thorax: Dorsal thoracic spines absent. General tubercles small or very small, absent on some specimens <20 OCL (merely punctate); tubercles rather dense to sparse, very sparse or absent on some animals <20 OCL. 2-4 cervical spines on specimens >20 OCL; spines small (rarely medium-sized) or tiny and blunt (rarely moderate) to very blunt, vague or absent on specimens <20 OCL.

ArL/OCL 0.37-0.41; CaW/OCL 0.50-0.55 i; ArW/OCL 0.15-0.19 d; CaD/OCL 0.44-0.49 d.

Abdomen: Somite 1 lacking D and D-L spines. Somite 2 with 2-3 small or tiny, blunt or very blunt Li spines on specimens >30 OCL, 1-2 spines on some specimens 20-30 OCL; spines often merely bumps. A tiny, very blunt Li spine sometimes on somites 3 and 4 of large specimens. 1-3 tiny, very blunt Lii spines (little more than setal bumps) on somites 3-6 of some large specimens. D and D-L spines absent. Specimens <20 OCL lacking abdominal spines. Dorsal abdominal boss absent.

AbdW/OCL ♂ 0.44-0.49, ♀ 0.45-0.56 i; OCL/L 0.38-0.43 i.

Tailfan: Tailfan spines absent, though setal bumps usually obvious on margins of uropods. Standard spines small or medium/small on specimens >20 OCL, medium-sized on smaller animals.

TeL/OCL ♂ 0.32-0.38 d, ♀ 0.33-0.39 di.

Chelae: Chelae intermediate in shape to elongate, lateral propodal margin often slightly concave. Teeth well developed on most specimens >30 OCL.

Propodus: 1 lateral propodal spine row (ventral row absent); lateral spines small and rather sharp. Lateral spine ridge vague or absent. Usually 4 mesal propodal spines, sometimes 3 or 5 especially on regenerate chelae (one specimen with 6 spines on regenerate chela); usually distinct gap between distal and 2nd mesal spines. Dorsal apical propodal spines absent, except one large specimen with 1 spine on one chela. Usually 1 spine above propodal cutting edge of specimens >30 OCL and on many smaller animals (one specimen with 2 spines on its larger chela); spines apical and medium-sized or small; spines usually absent on specimens <20 OCL. Dorsally 1-6 usually small spines lateral to dactylar base, with some small lateral bumps; ventrally 1-8 small spines, often in row extending along finger; specimens <20 OCL often lacking dorsal and ventral spines. Spines proximal to dactylar articulation absent; precarpal spines absent.

PropL/OCL ♂ 0.88-1.08 i, ♀ 0.87-1.01 i; PropW/PropL 0.39-0.45; PropD/PropL 0.28-0.34.

Dactylus: 1 apical spine above dactylar cutting edge (some regenerate chelae with 0 or 2 spines), some very small specimens lacking spine; spine medium-sized to small. Extra dorsal dactylar spines absent. Mesal dactylar basal spines absent. Usually 2 apical mesal dactylar spines, 1 on some very small animals. Dactylar groove present though shallow on specimens >30 OCL.

DactL/PropL 0.49-0.55.

Carpus: Dorsolongitudinal groove deep. Usually 4-5 mesal carpal spines, distalmost spine sometimes very small and always smaller than 2nd; relative sizes of 3rd to 5th spines variable. Usually small or tiny lateral carpal spine, sometimes absent. Articulation spine small or absent; dorsal carpal spine usually present. Ventral carpal spine small to medium-sized. 3-7 ventromesal spines, largest medium-sized to large and longer than ventral spine.

Merus: 8-12 small dorsal meral spines. Outer meral spine small or tiny.

Keel: Pr1: Posterior margins usually abrupt or semi-abrupt; processes angled back, close and parallel. Keel after Pr1 low and lacking spines.

Pr2: Close or slightly apart and usually parallel (rarely slightly closed). Keel after Pr2 low or very slightly pronounced.

Pr3: Usually parallel (sometimes slightly closed), posterior edges moderate to sharp, lacking scoops. Keel after Pr3 raised, very raised on small specimens, usually most pronounced centrally.

Pr4: Moderately rounded to sharp, scoops absent; anterior edges angular or very angular, posterior edges convex, irregular, or approximately straight.

Processes 3 and 4 usually distinctly narrow, almost broad on some specimens <20 OCL.

Setation: Heavy.

Punctation: Dense or very dense.

Gastric mill: TAP count 3.5 (rarely 3.0); TAA count 1.0 (rarely 1.5); spread 2.0-2.5. Urocardiac ridges 4-7 (usually 5-6). Urocardiac ossicle shallow.

Coloration: Body dark red/brown dorsally, paler ventrolaterally. Cephalic and cervical spines pale yellow. Often blue/violet tinge on lateral margins of abdominal somites. Carpus and propodus of cheliped with dark green mottling on orange or brown, mesal spines dark green. Fingers dark green/brown, sometimes with a blue tinge, tips pale brown.

Body orange and cream ventrally. Carpus of cheliped dark green or green/blue mesally, orange and cream laterally, ventral spines orange. Propodus cream or pale orange with darker orange or green mottling, mesal edge green. Fingers pale orange or blue/green.

Sexes: Males possess a rather wide cuticle partition. One female 20-30 OCL and three of the four females in the 30-40 OCL range have gonopores that appear to be opening or are very deeply incised. The largest female (OCL 38.5 mm, collected recently) is berried. It appears that females mature at close to 40 OCL.

Distribution and biology. The species has been collected from tributaries of the Pine River at altitudes above 500 m a.s.l. in rainforest in Maiala National Park near Mt Glorious, northwest of Brisbane, Queensland. Rainforest elsewhere in the area has been extensively cleared though it persists in some gullies of national parks and state forests. Higher ridges support sclerophyll forests. The berried

female was collected in early October. Eggs are maroon. A species of *Cherax* occurs widely at lower altitudes.

Remarks. While *E. setosus* probably occurs elsewhere in the D'Aguilar Range, only the type locality has yielded specimens.

Euastacus urospinosus (Riek)

Figures 21, 22

Euastacoides urospinosus Riek, 1956: 5-6.—Riek, 1969: 898.

Material examined. Holotype: Qld, Obi Obi Ck, Maleny, 8 Oct 1953, E.F. Riek, AM P12886, ♂, OCL 13.9 mm.

Other specimens: Qld, Tributary of Obi Obi Ck, above falls, Mapleton Falls National Park, (26°38'S, 152°52'E), 7 Oct 1982, G.J. Morgan and S.J. Harders, QM W10959, 5♂, 2♀.

Diagnosis. As for *E. setosus*, except: Rostral marginal spine row not reaching proximal to midlength of carinae. Suborbital spine small, rarely medium-sized. 1-3 small blunt thoracic spines posterior to cervical spines (>30 OCL). General tubercles sparse. 2-3 small Li spines on abdominal somite 2, sometimes merely bumps. Spines above propodal cutting edge absent. 5 (rarely 6) mesal propodal spines. 1 apical mesal dactylar spine. 4 mesal carpal spines. TAP count 2.5-3.0.

Description. Maximum OCL: 36.7 mm (none collected in 20-30 OCL range).

Rostrum: Rostrum very short, not reaching base of 3rd antennal segment, just distal to base on smallest specimen (holotype). Rostral sides slightly convergent or parallel; rostral base divergent and carinae spread. Usually 1-2 marginal spines per side; spines small, moderately pointed to rounded, apical or to midlength of carinae. Usually 1-3 low carinal bumps posterior to spines. Acumen spine similar to marginal spines.

OCL/CL 0.83-0.90 i; RW/OCL 0.12-0.17 d.

Cephalon: Spination moderate on large specimens, poor on specimens <20 OCL, with several small spaced spines (sometimes 1 distinctly larger) ventral to postorbital ridges. 1st postorbital spine small, medium-sized on smallest animal (holotype). 2nd postorbital spine absent or on one side only; when present, spine an edge or small. Suborbital spine small or medium-small, medium-sized on some specimens <20 OCL. Lateral margin of antennal squame straight or slightly irregular; squame widest very proximal to midlength, at approximately midlength on smallest specimen; marginal spines absent. Interantennal spine elongate on specimens >30 OCL, rather broad on specimens <20 OCL; margin slightly serrated. Antennal basipodite spine very small or small, occasionally absent; coxopodite spine very small or small, usually very weakly bifid.

ScL/OCL 0.13-0.18 d.

Thorax: On specimens >30 OCL, 1-3 small, blunt or moderately sharp dorsal spines immediately dorsal and posterior to cervical spines; animals <20 OCL lacking dorsal spines. General tubercles small or very small, sparse or very sparse. 2-5 cervical spines per side, small or very small and moderately pointed on specimens >30 OCL, blunt on animals <20 OCL.

ArL/OCL 0.38-0.42 i; CaW/OCL 0.54-0.56; ArW/OCL 0.12-0.18 d; CaD/OCL 0.45-0.52 d.

Abdomen: Somite 1 lacking D and D-L spines. On somite 2, 2-3 small or tiny, moderately pointed or blunt Li spines on most specimens >30 OCL (sometimes merely bumps); spines absent on specimens <20 OCL. Subsequent somites lacking Li spines. Lii, D-L and D spines absent, sometimes setal bumps in Lii position. Dorsal abdominal boss absent.

AbdW/OCL 0.45-0.50; OCL/L 0.39-0.44 i.

Tailfan: Tailfan spines absent, setal bumps obvious on margins of uropods. Standard spines small on specimens >30 OCL, medium-sized on specimens <20 OCL.

TeL/OCL 0.30-0.37 d.

Chelae: Chelae intermediate in shape or elongate. Teeth well developed on specimens >30 OCL.

Propodus: 1 lateral propodal spine row (ventral row absent); lateral spines small and rather sharp. Lateral ridge absent. Usually 5(rarely 6) mesal propodal spines, 4 on some regenerate chelae. Dorsal apical spines absent. Spines above cutting edge absent (one regenerate chela with single spine). Dorsally, 1 or 2 medium-sized or small spines lateral to dactylar base, with few small bumps; ventrally, 1 small or medium-sized spine, sometimes with several tiny bumps distributed slightly along finger. Spines proximal to dactylar base absent. Precarpal spines absent.

PropL/OCL (0.81)0.83-0.98 i; PropW/PropL 0.44-0.49; PropD/PropL 0.28-0.30.

Dactylus: 1 apical, medium-sized spine above dactylar cutting edge of specimens >30 OCL (one regenerate chela with 2 spines); specimens <20 OCL lacking spines. Extra dactylar dorsal spines absent. Mesal dactylar basal spines absent. Usually 1 apical mesal dactylar spine (some regenerate chelae lacking or with 2 spines). Dactylar groove shallow or distinct.

DactL/PropL 0.56-0.58.

Carpus: Dorsolongitudinal groove deep. 4 mesal carpal spines; distalmost spine smaller than 2nd, 4th often very small on specimens <20 OCL. 2 small lateral carpal spines, 1 on some specimens <20 OCL. Articulation spine present on some specimens <20 OCL. 1-2 small dorsal carpal spines, except on smallest specimen (holotype). Ventral carpal spine medium/large to small. Usually 3-4 ventromesal spines, largest medium-sized to large and larger than ventral spine.

Merus: 7-10 small dorsal meral spines. Outer spine small or tiny.

Keel: Pr1: Posterior margins semi-abrupt or abrupt, profiles usually angled back, rarely flat; processes close (rarely slightly apart) and parallel. Keel after Pr1 occasionally with small sharp spine.

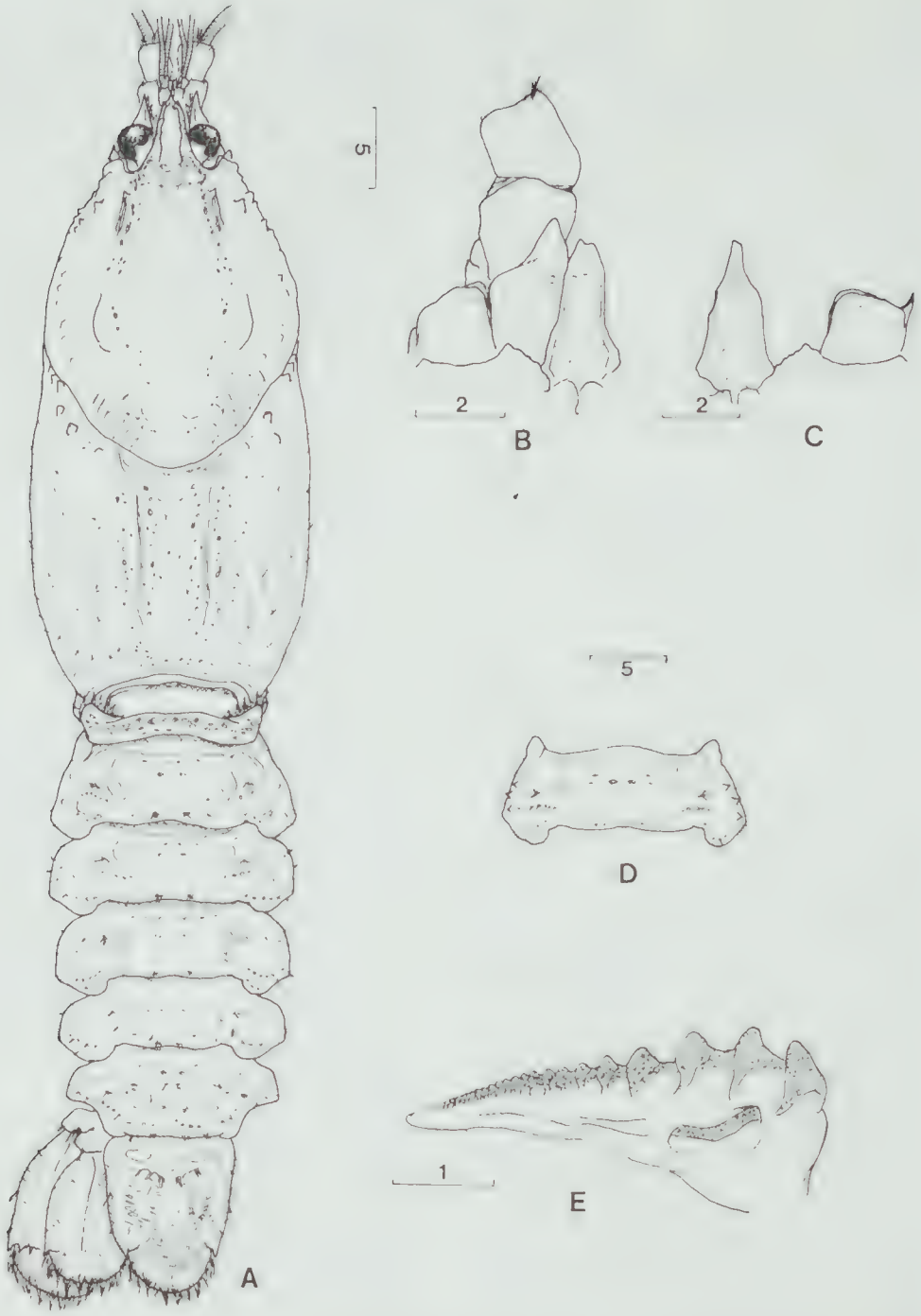

Figure 21. *Euastacus urospinosus*. (All specimens from Mapleton Falls, QM W10959). A, dorsal view (♂); B, ventral view cephalon (suborbital spine deformed) (♂); C, ventral view cephalon (♂); D, abdominal somite 2: Li spines distinct (♀); E, zygocardiac ossicle (♂).

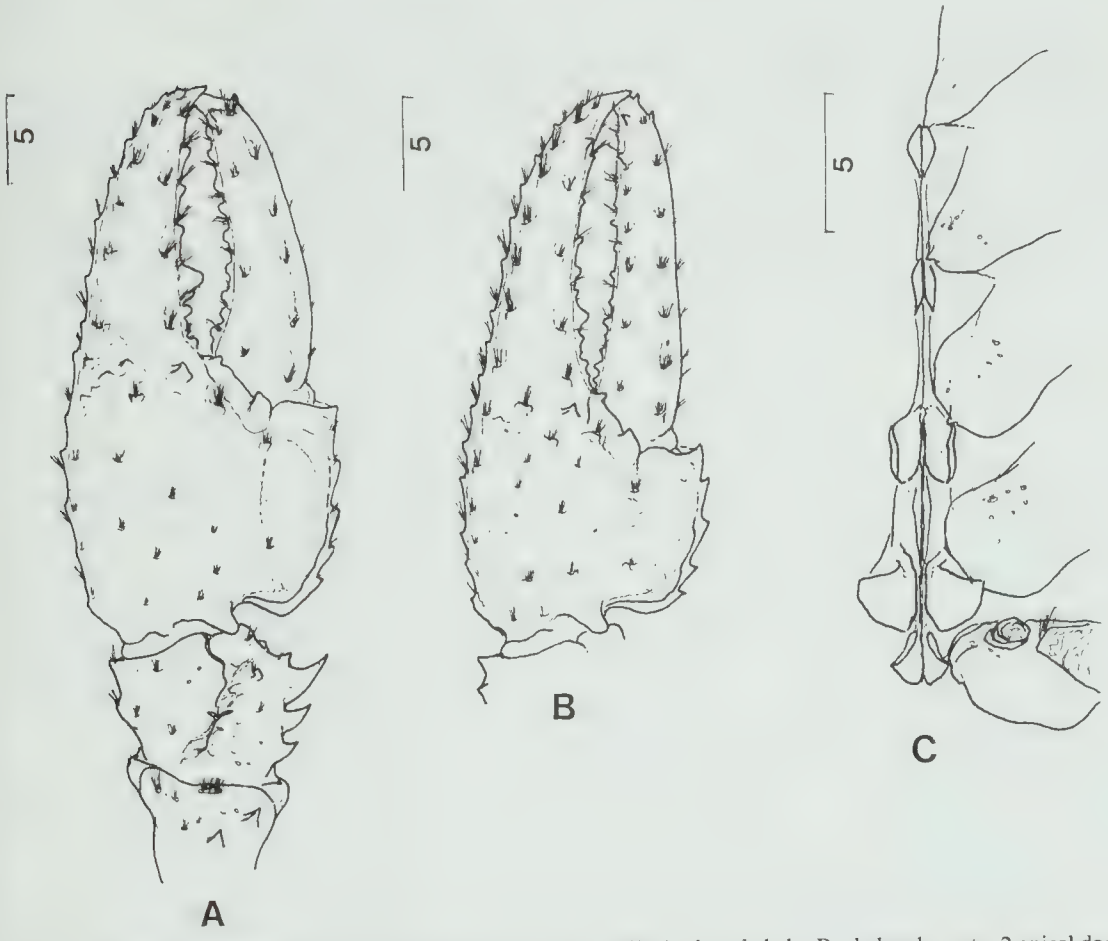

Figure 22. *Euastacus urospinosus.* (All from males, QM W10959). A, dorsal chela; B, chela: elongate, 2 apical dactylar spines, spine present above propodal cutting edge, (regenerate); C, sternal keel.

Pr2: Parallel and close on large specimens, apart on some animals <20 OCL. Keel after Pr2 usually saddle-shaped, sometimes with small spine.

Pr3: Usually approximately parallel, lateral profile sharp or moderate, scoops absent or very gradual. Keel after Pr3 distinctly raised, usually posteriorly pronounced.

Pr4: Scoops absent, laterally moderately curved or sharp; anterior edges angular, posterior slightly or distinctly convex.

Processes 3 and 4 narrow on specimens >30 OCL, broad on some animals <20 OCL.

Setation: Moderate to light.

Punctation: Sparse or moderate on cephalon, denser on thorax.

Gastric mill: TAP count 2.5-3.0; TAA count 1.0-1.5; spread 1.0-2.0. Urocardiac ridges 5-6. Urocardiac ossicle rather shallow.

Coloration: Body red-brown with green tinges dorsally, paler ventrolaterally. Blue tinges on lateral cephalon. Cervical and cephalic spines pale orange or yellow. Abdominal somites blue/violet laterally. Abdominal Li spines pale yellow. Carpus of cheliped orange with dark green/brown mottling, distolateral edge bright orange, mesal spines dark green. Propodus ochre with green mottling, edges green or blue/green. Fingers green with blue tinges, tips paler yellow.

Body pale orange, yellow and cream ventrally. Carpus of cheliped dark green or blue/green mesally, orange laterally, ventral spine orange. Propodus mostly cream with blue mottling, mesal area orange with green mottling. Fingers blue and cream.

Sexes: Males possess a cuticle partition. No mature females have been collected and only one female >30 mm OCL is known.

Distribution and biology. The species is known only from tributaries of Obi Obi Creek (Mary River) between Maleny and Mapleton, west of Nambour,in rainforest at altitudes above 240m. Little highland rainforest remains uncleared in the area, though pockets persist in national parks and state forests. Vegetation at the type locality has been cleared for

pasture as it was in 1953 when the juvenile holotype was collected (Riek, 1956). This specimen was probably washed downstream from upstream rainforest. Species of *Cherax* and *Macrobrachium* are common in streams with cleared banks and at lower altitudes.

Remarks. This small species has been sampled from essentially a single site. *Euastacus urospinosus* was described by Riek (1956) on the basis of one very small specimen (OCL 13.9 mm) which does not display the characteristics of larger animals.

Euastacus maidae (Riek)

Figure 23

Euastacoides maidae Riek, 1956: 5.—Riek, 1969: 898.

Material examined. Holotype: Qld, upper reaches of Currumbin Ck, 1 Dec 1953, E.F.Riek, AM P12888, ♂, OCL 24.8 mm.

Allotype: Type locality, AM P12888 ♀, OCL 21.9 mm.

Diagnosis. As for *E. setosus,* except: Antennal squame widest at midlength. Suborbital spine small. 4-6 small Li spines on abdominal somite 2. 1-2 dorsal apical propodal spines. Spines above propodal cutting edge absent. 3-4 mesal propodal spines. 1-2 apical mesal dactylar spines. 4 mesal carpal spines.

Description. 2 specimens, OCL 24.8 mm, 21.9 mm.

Rostrum: Rostrum very short, not reaching or just reaching base of 3rd antennal segment. Rostral sides slightly convergent or almost parallel. Base divergent or very divergent, carinae spread. 3-4 marginal spines distributed along full length or carinae; spines medium-sized, moderately pointed or rounded. Acumen spine similar to marginal spines.

OCL/CL 0.87-0.88; RW/OCL 0.14-0.15.

Cephalon: Cephalon moderately spiny or spiny with 2-3 small spines and several small bumps ventral to postorbital ridges. 1st postorbital spine small; 2nd spine small on one specimen, absent on other. Suborbital spine small. Lateral margin of squame straight; squame widest at midlength; marginal spines absent. Interantennal spine medium width, margin slightly serrated. Antennal basipodite spine absent or very small; coxopodite spine small and bifid.

ScL/OCL 0.15.

Thorax: Dorsal thoracic spines absent. General tubercles small or very small and moderately dense. Approximately 4 cervical spines per side, small or tiny and blunt.

ArL/OCL 0.36-0.37; CaW/OCL 0.49-0.50; ArW/OCL 0.16; CaD/OCL 0.44-0.45.

Abdomen: Somite 1 lacking D and D-L spines. Somite 2 with 4-6 small or tiny, moderately pointed to blunt Li spines. Lii, D-L and D spines absent. Dorsal abdominal boss absent.

AbdW/OCL 0.46-0.48; OCL/L 0.40-0.41.

Tailfan: Tailfan spines absent, marginal setal bumps on uropods. Standard spines small.

TeL/OCL 0.34-0.35.

Chelae: Chelae elongate, with lateral propodal margins slightly concave. Teeth moderately developed on both specimens (indicating further growth to maximum size).

Propodus: Single lateral propodal spine row (ventral row absent). Lateral spines small and rather sharp. Lateral spine ridge absent. 3-4 mesal propodal spines, with distinct gap between 1st (distal) and 2nd. 1-2 dorsal apical spines. Spines above cutting edge absent. 1-2 small or medium-sized spines lateral to dactylar base dorsally, with few slight bumps; ventrally, 1 small or medium-sized spine. Spines proximal to dactylar articulation absent. Precarpal spines absent.

PropL/OCL ♂ 1.02, ♀ 0.94; PropW/PropL 0.40-0.42; PropD/PropL 0.27-0.28.

Dactylus: 1 large or medium-sized apical spine above dactylar cutting edge. Extra dorsal dactylar spines absent. Mesal dactylar basal spines absent. 1-2 apical mesal dactylar spines. Dactylar groove shallow.

DactL/PropL 0.53-0.54.

Carpus: Dorsolongitudinal groove deep. 4 mesal carpal spines. Distalmost spine considerably larger than others, which decrease in size proximally. 1 small lateral carpal spine. Articulation and dorsal carpal spines absent. Ventral carpal spine very small or tiny. 2-4 ventromesal spines, with largest large or moderately large and much larger than ventral spine.

Merus: 5-8 small dorsal meral spines. Outer meral spine tiny.

Keel: Prl: Posterior margins semi-abrupt, ventral edges angled down; processes close and parallel. Keel after Prl low, sometimes slight anterior bump.

Pr2: Open and slightly apart. Keel after Pr2 low, recessed anteriorly.

Pr3: Lateral profile moderately sharp, with rounded bases and gradual scoops. Keel after Pr3 not prominantly raised.

Pr4: Lateral profile moderately sharp, scoops absent; anterior edges angular, posterior edges straight or slightly concave.

Pr3 and 4 narrow.

Setation: Moderate to moderately heavy.

Punctation: Dense.

Gastric mill: TAP count 3.5; TAA count 1.0-1.5; spread 2.0-2.5. Urocardiac ridges 4-5. Urocardiac ossicle shallow.

Coloration: No live specimens of *E. maidae* were collected during this study. Riek (1956) described *E. maidae* as "rather nondescript with some bluish tinge on abdomen and great chelae".

Sexes: The male bears a cuticle partition. The small female (allotype) has unopen gonopores.

Distribution and biology. The species is known only from rainforest at the upper reaches of Currumbin Creek, west of Coolangatta, south-east Queensland. Riek (1956) noted that it was collected "in association with *E. sulcatus* and a second species of *Euastacus* of which only juveniles were seen."

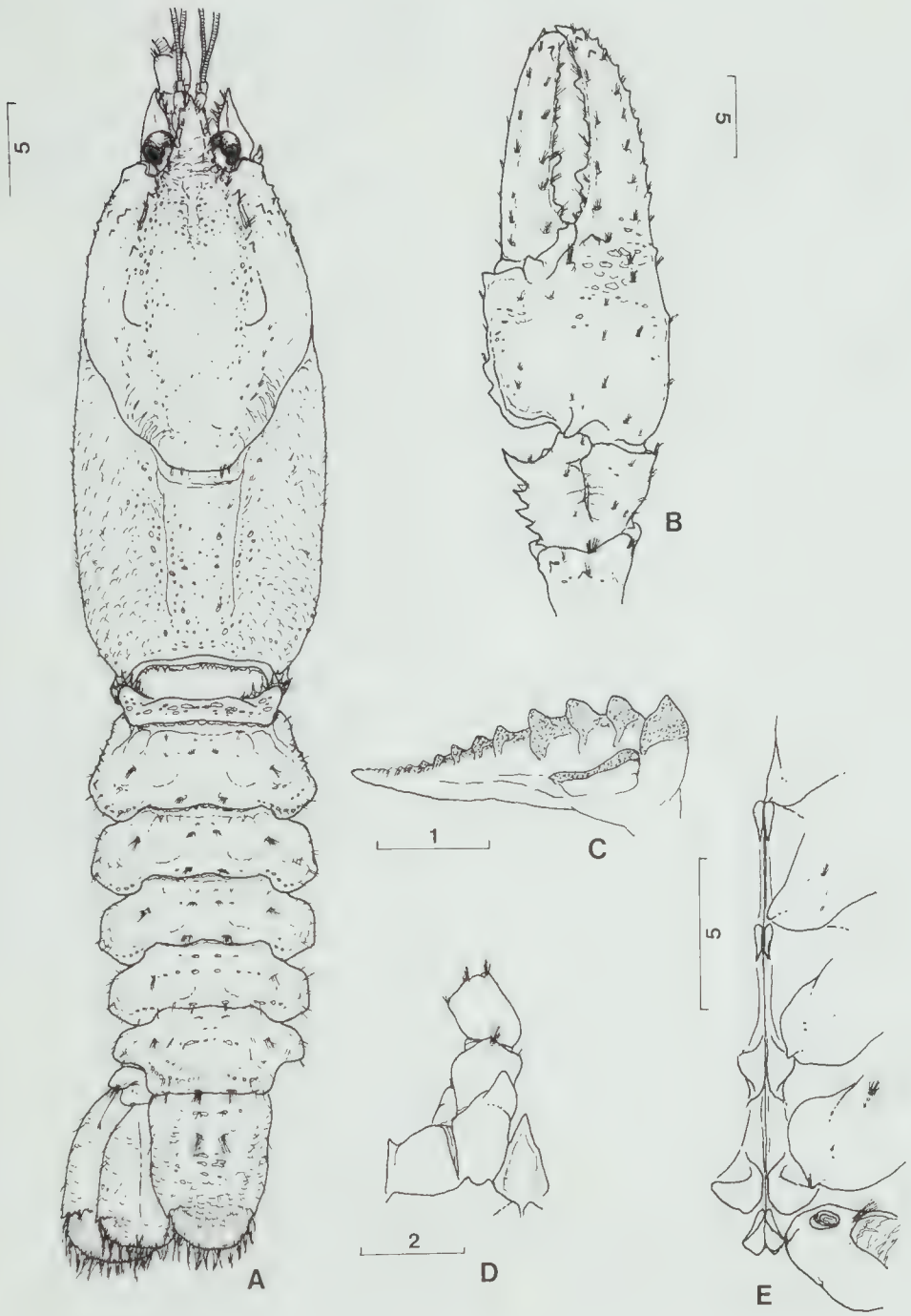

Figure 23. *Euastacus maidae*. A, dorsal view (holotype ♂, Currumbin Ck, AM P12888); B, dorsal view chela (holotype ♂); C, zygocardiac ossicle (holotype ♂, Francois collection); D, ventral view cephalon (allotype ♀, AM P12888); E, sternal keel (holotype ♂).

Remarks. Euastacus maidae is known from only two specimens from the type locality, both specimens falling in the arbitrary size class of 20-30 OCL. Riek (1969: 898) recorded additional specimens from the type locality in the AM but these could not be located for this study and there is no record of them on the museum registry.

Euastacus jagara sp. nov.

Figures 24, 25

Material examined. Holotype: Qld, Flaggy Ck, 3000 ft, Mistake Mts via Laidley, 11 Feb 1973, S. and G. Montieth, QM W6471, ♂, OCL approx. 47.1 mm.

Paratypes: Qld, type locality, QM W6471, 1♂, 4♀.

Diagnosis. As for *E. setosus,* except: Rostral spines apical or in row reaching midlength of carinae. Antennal squame widest proximal to midlength. Suborbital spine small. General tubercles sparse. Spines above propodal cutting edge absent. 6-7 mesal propodal spines. 1 apical mesal dactylar spine. 3-6 mesal carpal spines. Keel Pr1 sloped or almost semi-abrupt. TAP count 4.0.

Description. Maximum OCL: 47.1 mm (approximate, carapace broken).

Rostrum: Rostrum very short, not reaching base of 3rd antennal segment (except on one specimen <20 OCL). Rostral sides slightly convergent or almost parallel. Rostral bases divergent or very divergent, carinae spread. 1-2 marginal spines per side, apical or distributed to midlength of carinae; spines small or medium/small and moderately sharp. Acumen spine similar to marginals.

OCL/CL 0.87-0.89; RW/OCL 0.12-0.17 d.

Cephalon: Cephalic spination poor or moderately poor, with 1-2 small spines and several bumps below postorbital ridges. 1st postorbital spine small edge on largest specimen, small on specimens <30 OCL. 2nd postorbital spine small edge on largest animal, edge on specimens <30 OCL. Suborbital spine very small or small. Lateral margin of squame slightly convex, concave or straight; squame widest proximal to midlength; marginal spines absent. Interantennal spine elongate on specimens >20 OCL, medium width on smaller animals; margins slightly or distinctly serrated. Antennal basipodite spine very small or absent; coxopodite spine medium-sized to small, usually weakly bifid.

ScL/OCL 0.13-0.19 d.

Thorax: Dorsal thoracic spines absent (largest specimen, holotype, with much of branchiostegites missing, but no evidence of spines). General tubercles small or very small, sparse or very sparse; specimens <20 OCL lacking tubercles. 2-5 cervical spines per side, small and moderately pointed to blunt.

ArL/OCL 0.38-0.44 i; CaW/OCL 0.51-0.54; ArW/OCL 0.16-0.18 (largest missing); CaD/OCL 0.46-0.49 d.

Abdomen: Somite 1 lacking D-L and D spines. Largest specimen (holotype) with 2-3 small, very blunt Li spines on somite 2 (little more than bumps); other specimens lacking spines. Low Li and Lii bumps on somites 3 and 4 of holotype. D-L and D spines and dorsal boss absent.

AbdW/OCL 0.46-0.48; OCL/L 0.41-0.46 i.

Tailfan: Tailfan spines absent; marginal setal bumps on uropods. Standard spines very small on largest specimen, small to medium-sized on smaller animals.

TeL/OCL 0.29-0.36 d.

Chelae: Chelae elongate. Teeth well developed on specimens near or >30 OCL.

Propodus: 1 lateral propodal spine row (ventral row absent); lateral spines small and rather sharp. Lateral spine ridge vague or absent. 6-7 mesal spines on normal chelae of specimens >20 OCL, 4-5 on smaller animals. Dorsal apical propodal spines and spines above cutting edge absent. Spines usually absent lateral to dactylar base dorsally and ventrally, low setal bumps often present. Spines absent proximal to dactylar base, very low bumps sometimes present. Precarpal spines absent.

PropL/OCL 0.81-0.97 i; PropW/PropL 0.38-0.44; PropD/PropL 0.28-0.32.

Dactylus: Largest specimen with 1 small apical spine above dactylar cutting edge; specimens <30 OCL lacking spines. Extra dorsal dactylar spines and mesal basal spines absent. 1 apical mesal spine (vague on smallest specimen). Dactylar groove present.

DactL/PropL 0.54-0.56.

Carpus: Dorsolongitudinal groove deep. 3-6 mesal carpal spines, 3 or 4 spines usually distinctly larger than others; distalmost spine often smaller than 2nd and sometimes absent; 3rd and 4th spines usually small. 1-2 small or very small lateral carpal spines. Articulation spine absent. Dorsal carpal spines absent (low bumps on largest specimen). Ventral spine medium-sized or medium/small on specimens >20 OCL, small or very small on lesser crayfish. Largest ventromesal spine medium/large or medium-sized on specimens >20 OCL, small or very small on lesser specimens, and larger than or similar size to ventral spine; other ventromesal spines tiny.

Merus: 7-10 very small dorsal meral spines. Outer spine absent or tiny on specimens >20 OCL, small on lesser crayfish.

Keel: Pr1: Posterior margins sloped or almost semi-abrupt; ventral profile angled down or slightly back; processes close and parallel. Keel after Pr1 lacking distinct spines, sometimes slight bump.

Pr2: Processes parallel, close or slightly apart on specimens >20 OCL, slightly or distinctly apart on smaller animals. Keel after Pr2 low, sometimes slightly pronounced anteriorly.

Pr3: Slight or gradual scoops, moderate or rounded. Keel after Pr3 low on largest specimen, moderately to distinctly pronounced on smaller crayfish.

Pr4: Posterior edge bases moderately curved without scoops (rarely slight scoops), slightly or distinctly convex; anterior edges rounded on largest specimen, rounded to angular on specimens 20-30 OCL, angular on smaller crayfish.

Processes 3 and 4 distinctly narrow on largest speci-

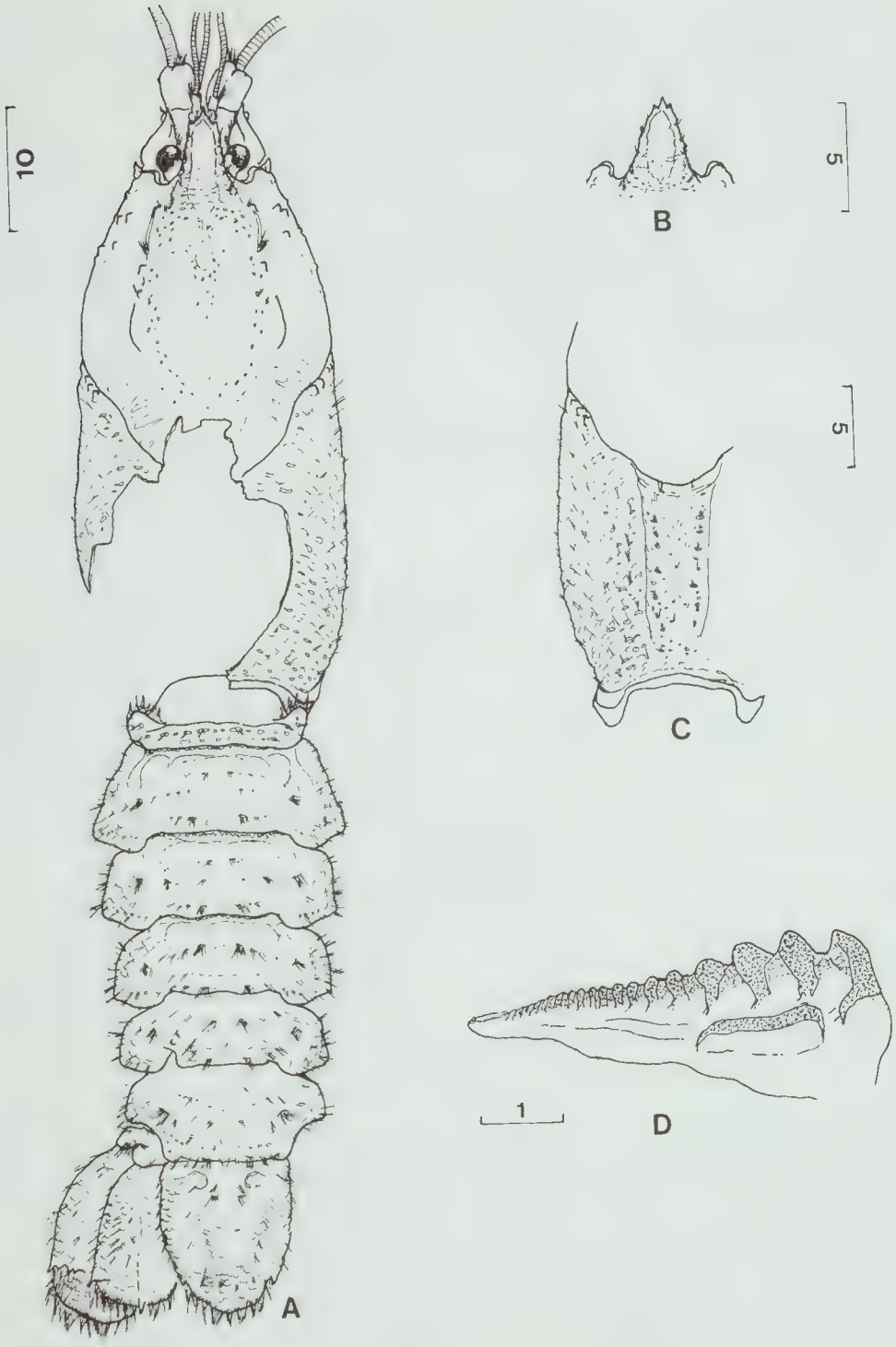

Figure 24. *Euastacus jagara*. A, dorsal view (holotype ♂, Flaggy Ck, QM W6471); B, rostrum: broader (paratype ♀, QM W6471); C, thorax: illustrating areola width and tubercles (paratype ♀); D, zygocardiac ossicle (holotype ♂).

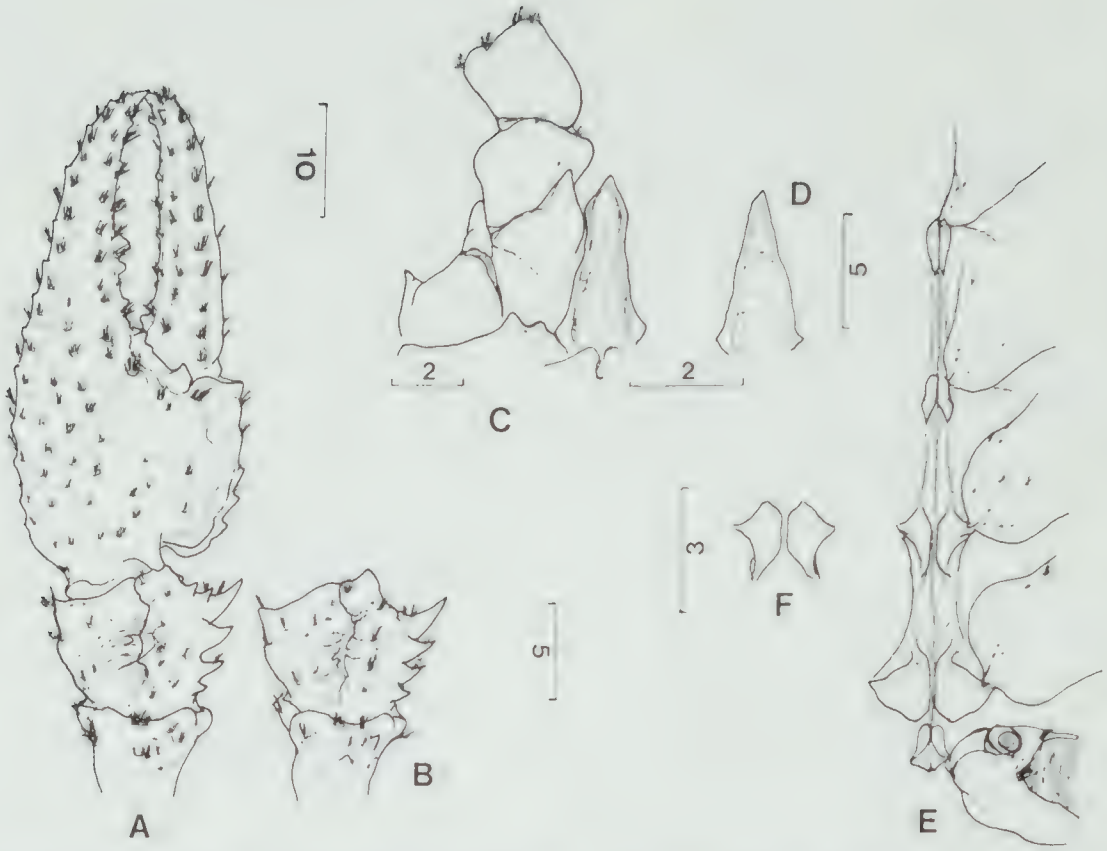

Figure 25. *Euastacus jagara*. A, dorsal view chela (holotype ♂); B, carpus: no distinct spines distal to mesal spines (paratype ♀); C, ventral view cephalon (holotype ♂); D, interantennal spine (paratype ♀); E, sternal keel (holotype ♂); F, keel Pr 3: broader (allometry) (paratype ♀).

men, just narrow on specimens 20-30 OCL, just broad on smaller crayfish.

Setation: Moderate to heavy.

Punctation: Moderate on largest specimen, dense on smaller specimens.

Gastric mill: TAP count 4.0; TAA count 1.0-1.5: spread 2.5-3.0. Urocardiac ridges 5-7. Urocardiac ossicle shallow.

Coloration: No specimens of *E. jagara* were collected for this study and museum records bear no mention of colours of live crayfish.

Sexes: Males possess a wide cuticle partition. No mature females have been collected. Those in the 20-30 OCL range have closed gonopores, though pores of one specimen appear deeply incised.

Distribution and biology. The species is known only from the type locality at 920 m a.s.l. in the Mistake Mountains, approximately 50 km south-west of Ipswich. The range is drained by tributaries of the Brisbane River and supports rainforest along stream banks. *Cherax* and *Macrobrachium* were found at lower elevations. Further collection may reveal a boundary between the ranges of *E. jagara* and *E. sulcatus* to the south, though the species may be sympatric in places.

Etymology. Named after Jagara, the probable aboriginal language of the Mistake Mts area (Capell, 1963).

General remarks

The four species, *E. setosus, E. urospinosus, E. maidae* and *E. jagara* form an identifiable group of species in south-east Queensland. The first three species were regarded by Riek (1956) as members of the genus *Euastacoides* and are similar in many respects with *E. jagara*. The genus is here synonymised with *Euastacus*. The four species may be regarded as members of a *setosus* species complex (species complex defined by Mayr, 1969), named for the best collected of the species. In separating *Euastacoides* from *Euastacus*, Riek (1956) cited two generic diagnostic characters (characters 1 and 3

below); in 1969 he added character 2 below. The name *Euastacoides* is retained in this discussion for convenience in comparisons with other *Euastacus*.

1. One lateral propodal spine row (i.e. the absence of a ventral row). This is valid for all four species of *Euastacoides* but does not distinguish the genus. Species of *Euastacus* show inter-(and often infra-) specific variation from 1 to 2 propodal rows, with most species displaying the 2 to 1 condition. Frequently the ventral propodal row is very poorly developed and most specimens of *E. reductus* Riek and many *E. neohirsutus* Riek from New South Wales have only 1 lateral spine row.

2. Carpus with irregular number of ventral spines (*Euastacus* should have only 1 enlarged spine).

There are usually several ventromesal (VM) spines on *Euastacoides* species and the largest is usually larger or much larger than the ventral (V) spine. In most species of *Euastacus* the V spine is larger or much larger than the largest VM spine but frequently there are several small VM spines. In some species (e.g., *E. reductus, E. neodiversus* Riek, *E. woiwuru* Morgan) however, the VM spine is similar to or larger than the V spine. The ventral surface of the carpus of *Euastacus reductus* and *Euastacoides* species can be very similar. The different populations of *Euastacoides* also display variation in the sizes and number of VM spines and the size of the V spine. The number of VM spines is usually lower on *E. maidae*. The *Euastacoides* condition is therefore uncommon but is exhibited by some *Euastacus*, especially the less spiny species.

3. *Euastacoides* lacks abdominal spines, having merely tufts of setae. The best collected population of *Euastacoides* is that from Mt Glorious (*E. setosus*). This species lacks sharp abdominal spines. However, some larger specimens have very obvious bumps on somite 2 in the position of the Li spines of *Euastacus* species. The question is whether to regard these bumps as blunt spines or to consider abdominal spines to be absent.

Euastacoides urospinosus from Obi Obi Ck in the high country west of Nambour, was described by Riek on the basis of one very small juvenile lacking abdominal spines, a character shared by similarly sized specimens of all species of *Euastacus*. Further sampling carried out for this study produced specimens of considerably greater size, including probably mature males and an almost mature female. While abdominal spination is uniformly poor, there are definitely small, moderately sharp or blunt Li spines on somite 2 of several large specimens. Those that lack distinct sharp spines possess bumps similar to those of *E. setosus*.

The two type specimens of *E. maidae* collected by Riek from upper Currumbin Ck remain the only known specimens of this species. Contrary to Riek's (1956) description, both crayfish possess small, moderately sharp or blunt Li spines on somite 2.

The population of *Euastacoides*-like crayfish from Flaggy Ck (*E. jagara*) is similar to *E. setosus* in possessing distinct abdominal bumps.

In summary, the absence of abdominal spines is not a constant feature of these crayfish. *Euastacus* displays extreme interspecific (and often infraspecific) variation in the size and number of abdominal spines. Some species (e.g. *E. reductus* and many specimens of *E. neohirsutus*) display very reduced abdominal spination, with small Li spines only on somite 2 and setal bumps on subsequent somites. This condition is similar to that of *E. maidae* and some *E. urospinosus*. It appears that the pleural bumps are vestigial spines and that in *E. setosus* extreme reduction of the characters is represented. Hence, an absence of abdominal spines does not distinguish *Euastacoides* from *Euastacus*.

In addition to the three generic diagnostic characters of Riek, there are several other morphological features worthy of discussion.

4. Squamal shape. The antennal squame of *E. setosus* and *E. urospinosus* is distinctly thinner and more elongate than that of other species of *Euastacus*. Riek (1956) described the squame of *E. urospinosus* as obviously broader than that of *E. setosus* and widest at approximately its midlength but this is not a valid specific difference. The squame of *E. urospinosus* is broadest at its midlength only on the very small juvenile holotype; larger specimens have a squame similar to that of *E. setosus*. The squame of *E. maidae* and *E. jagara* is rather broader and in the former species widest at approximately its midlength. The squame of *E. maidae* is similar to most *Euastacus* scales. If *E. maidae* is grouped with *E. setosus* and *E. urospinosus*, a thin squame is not a generically diagnostic character.

5. Overall reduction in spination. The reduction in abdominal spination has already been discussed in character 3. The species of *Euastacoides* also display reduced spination on the chelae and thorax. However, similarly poor spination is evident in some species of *Euastacus* (e.g. *E. reductus, E. simplex* Riek and *E. brachythorax* Riek).Larger specimens of *E. urospinosus* possess 1-3 very small, blunt thoracic spines behind the cervical spines, a condition common on poorly spined species of *Euastacus*.

6. Mesal carpal spination. The condition of the ventral carpal spines has been discussed above. The species *E. setosus* and *E. urospinosus* usually possess a small carpal spine distal to that corresponding to the first (distalmost) on most species of *Euastacus*, i.e. in contrast to most *Euastacus* the distalmost spine is usually not the largest. However, there is variation in carpal spination of these two *Euastacoides* species and some specimens lack the small first spine. In contrast to *E. setosus* and *E. urospinosus*, the two specimens of *E. maidae* display the usual *Euastacus* pattern with the first carpal spine largest. Specimens of *E. jagara* are somewhat intermediate: a small distal spine may be present but is usually absent or very weakly developed. Specimens of several species of *Euastacus* possess a small carpal spine or bump distal to the largest first spine, hence approaching the condition of *E. setosus* and *E. urospinosus*.

7. Sternal keel. The first keel processes (Pr1) are steeply angled back on *E. setosus* and *E. urospinosus*, an unusual condition for *Euastacus*. However, *E. maidae* and *E. jagara* have Pr1 angled down, a common *Euastacus* condition. Additionally, the 3rd processes (Pr3) are usually parallel in *E. setosus* and *E. urospinosus*, a rare condition in *Euastacus*, though usual for *E. simplex*. *Euastacoides maidae* and *E. jagara* display gradually scooped Pr3, similar to many *Euastacus*.

8. Gastric mill. The zygocardiac ossicles of *Euastacoides-type* crayfish have low tooth counts similar to those of many of species of *Euastacus*. The urocardiac ossicles are shallower than those of most *Euastacus* species but there is considerable variation in both *Euastacoides* and *Euastacus*, and *E. urospinosus* has ossicles deeper than those of *E. setosus*. *Euastacus reductus*, *E. neohirsutus* and *E. polysetosus* Riek possess shallow urocardiac ossicles similar to those of *Euastacoides*.

9. Inner ramus of uropod. The inner rami of the uropods are rather thin on the four *Euastacoides-type* species but variable in *Euastacus*. The rami of some *Euastacus* species (e.g., *E. simplex*) are similar to those of the *Euastacoides* types. The species *E. urospinosus* and *E. jagara* have the medial standard spine on the posterior edge of the uropod but in *E. maidae* the spine is slightly set in from the edge and in *E. setosus* distinctly so (usual for *Euastacus*).

In summary, there are no distinct and constant differences that warrant the separation of a genus *Euastacoides* from *Euastacus*. The three diagnostic characters described by Riek are invalid when sufficient specimens are examined. Additional potentially diagnostic characters described above are similarly inconstant.

The species regarded by Riek as belonging to *Euastacoides* are similar to *Euastacus reductus* of New South Wales in external morphology and gastric mills. *Euastacus reductus* displays obvious abdominal spines (frequently only on somite 2) and varying development of the ventrolateral propodal spine row. Hence, *E. reductus* cannot be included in Riek's *Euastacoides*, yet provides an intermediate condition between that occurring in this group and in most species of *Euastacus*. The *Euastacoides* species are better regarded as a branch of the extremely variable genus *Euastacus*, corresponding in general form and habitat to the small non-spiny, high country *Euastacus* of New South Wales and Victoria.

Euastacus fleckeri and *E. robertsi* of far northern Queensland also comprise a recognizable species group. They differ from other species of *Euastacus* in their shallow dorsolongitudinal carpal groove, the complete lack of mesal dactylar spination, the development of a large mesoventral carpal spine offset from the ventromesal spines, and the unclear distinction between thoracic spines and general tubercles. These differences, particularly the first, are regarded here as significant and the two species may warrant generic differentiation from *Euastacus*.

Though geographically closest to *E. fleckeri* and *E. robertsi*, *E. balanensis* most closely resembles *E. eungella* of the Clarke Range 500 km to the south. The two species are similar to each other in general appearance but can be readily distinguished, especially by the spination of the chelipeds and coloration.

The four large, spiny species of southeast Queensland, *E. sulcatus*, *E. hystricosus*, *E. suttoni* and *E. valentulus* can be distinguished by patterns of spination of the thorax, abdomen and chelae. They differ from most of the large *Euastacus* species of the southern states in possessing a male cuticle partition.

The distribution of *Euastacus* in Queensland is consistant with that of relic populations. With the exception of *E. valentulus* in the far south, all species are restricted to relatively high mountain or plateau country. The genus is confined to higher altitudes as latitude decreases. It is likely that *Euastacus* extended over larger areas of Queensland during geological periods of higher rainfall and/or cooler climates (e.g., 8,000-10,000 years B.P.). The crayfish are usually restricted to cool fast-flowing mountain streams and this habitat will have constricted as climatic regimes became warmer and drier.

Most Queensland *Euastacus* species are confined to or display strict preference for streams in rainforest or wet sclerophyll forest. The exception is *E. suttoni* inhabiting the open sclerophyll country of the New England plateau. The clearance of natural vegetation probably has restricted the ranges of most species.

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WATER MITES OF THE GENUS *ASPIDIOBATES* FROM VICTORIA, AUSTRALIA, WITH THE DESCRIPTION OF TWO NEW SPECIES (CHELICERATA: ACARINA: HYGROBATIDAE)

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Abstract

Harvey, M.S. and Cook, D.R. 1988. Water mites of the genus *Aspidiobates* from Victoria, Australia, with the description of two new species (Chelicerata: Acarina: Hygrobatidae). *Memoirs of the Museum of Victoria* 49: 51-57.

Five species of *Aspidiobates* Lundblad are recorded from Victoria, Australia: *A. bidewel* sp. nov., *A. aethes* sp. nov., *A. scutatus* Lundblad, *A. similis* Cook and *A. geometricus* Cook. A key to the Australian species of the genus is provided.

Introduction

Thirteen species of *Aspidiobates* Lundblad have been previously described, nine from New Caledonia (Viets, 1968), one from New Zealand (Hopkins, 1975, Cook, 1984) and three from Australia (Lundblad, 1941, Cook, 1986). Of the three described Australian species, only *A. scutatus* Lundblad has been recorded from Victoria (Cook, 1986). Recent field work has uncovered many additional specimens of five species of this genus, including representatives of two new species, specimens of which exhibit character states hitherto unrecorded in the genus. Thus, the opportunity is taken to describe these species, as well as provide new locality records for the three previously described Australian species.

Specimens are lodged in the Museum of Victoria, Melbourne (NMV), the Field Museum of Natural History, Chicago (FMNH) and the Canadian National Collection, Ottawa (CNC). Many specimens are mounted on microscope slides in glycerine jelly. The collection sites and station numbers of *A. aethes* are described by Malipatil and Blyth (1982) and Blyth et al. (1984), and unless otherwise stated, all material was collected by the Museum of Victoria's Biological Survey Department (now the Department of Environmental Records). Terminology follows Cook (1974), except for the terminology of the leg segments which follows Smith (1976). Measurements were taken to the nearest 5 μm and dimensions are usually given as length divided by width.

Hygrobatidae

Aspidiobates Lundblad

Aspidiobates Lundblad, 1941: 115.—Cook, 1974: 224-225. (Type species *Aspidiobates scutatus* Lundblad, 1941, by original designation.)

Remarks. The diagnosis provided by Cook (1974) is adequate except for the following amendations: three or four pairs of genital acetabula; legs relatively unmodified, except for males of one species in which the genu of the fourth leg is modified, and without swimming hairs.

Aspidiobates bidewel sp. nov.

Figures 1-13

Type material. Holotype male, Victoria, Bonang River, 4 km SSE of Bonang, D.R. Cook, M.S. Harvey and A.J. Boulton, 7 Apr 1985, NMV K354 (slide).

Paratypes: same data as holotype, NMV K355-367, 8 males, 5 females (slides and fluid); FMNH, 1 male, 1 female (slides); CNC 1 male, 1 female (slides).

Other material examined. Victoria, Yarra River at Maroondah Highway, collected by staff of Chisholm Institute, Oct 1980, NMV, 1 female (slide).

Diagnosis. Genu IV of male curved and with a ventral row of stout setae, the proximal ones spatulate.

Description. Dorsal and ventral shields present; dorsal shield of male (Fig. 1) entire, of female (Fig. 3) consisting of a large anterior plate and 2 pairs of narrow posterior platelets; male dorsal shield with first pair of glandularia slightly anterior to

Key to Australian species of *Aspidiobates*

1.	Genital field with 4 pairs of acetabula	*A. aethes*
—	Genital field with 3 pairs of acetabula	2
2(1).	Males	3
—	Females	6
3(2).	Dorsal shield entire; genu IV proximally curved, ventral margin with a row of stout setae	*A. bidewel*
—	Dorsal shield divided into at least 3 platelets; genu IV not curved, without stout setae	4
4(3).	Dorsal shield divided into 3 platelets	*A. geometricus*
—	Dorsal shield divided into 5 platelets	5
5(4).	Distance separating first pair of glandularia greater than distance separating second pair of glandularia; anus midway between genital field and posterior edge of ventral shield	*A. scutatus*
—	Distance separating first pair of glandularia equal to distance between second pair of glandularia; anus close to genital field	*A. similis*
6(2).	Dorsal shield divided into 6 platelets	*A. geometricus*
—	Dorsal shield divided into 5 platelets	7
7(6).	Distance separating first pair of glandularia greater than distance separating second pair of glandularia	*A. scutatus*
—	Distance separating first pair of glandularia equal to distance separating second pair of glandularia	8
8(7).	Dorsal shield approximately 850-960 μm in length	*A. similis*
—	Dorsal shield greater than 1100 μm in length	*A. bidewel*

postocularia and closer to postocularia than to lateral margins of plate; third pair of glandularia same distance apart as second pair of glandularia; female dorsal plate with first pair of glandularia slightly posterior to postocularia and closer to lateral margin of shield than to postocularia; ventral shield (Figs. 2, 4) with suture lines between third and fourth coxae at a moderate angle; glandularia of fourth coxae shifted onto the third coxae but not approaching edge of third coxae; genital field with 3 pairs of acetabula (Figs. 5, 10), anterior pair slightly elongate (anterior pair absent in one female, and partially absent in another); anus on same level as posterior pair of ventroglandularia. Palp (Figs. 9, 11): genu of male with more dorsal setae than that of female. Legs (Figs. 6-8, 12-13): swimming setae absent; telofemur of male leg I thickened and with many thin setae; genu of male leg IV proximally curved, ventral margin with a row of stout setae, the proximal ones distally spatulate.

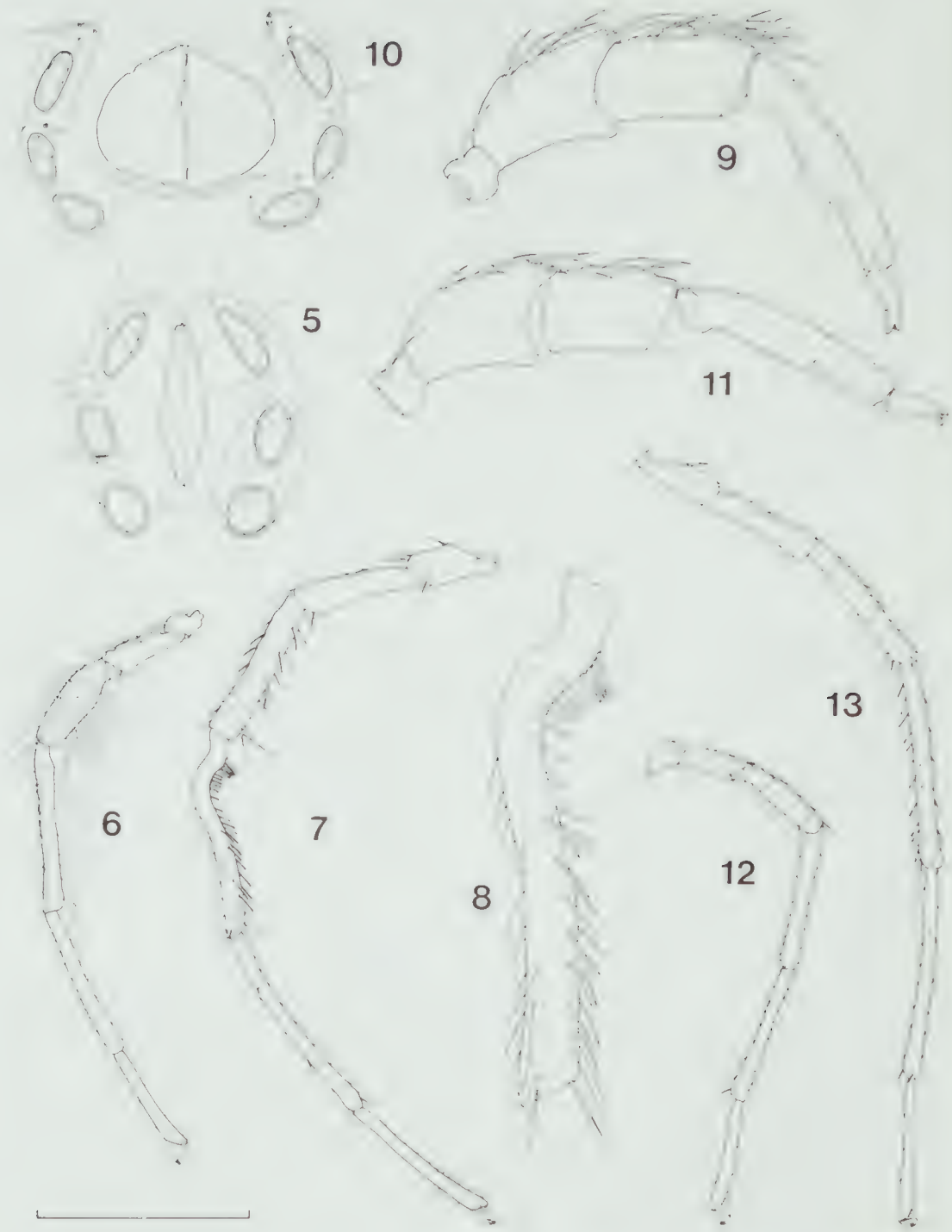
Dimensions (μm) male (female): Dorsal shield 1240-1305/ 1000-1095 (1175-1210/1000-1030), large dorsal plate length (1065-1160), anterior platelet length (510--540), posterior platelet length (320-360), ventral shield 1320-1415/1155-1260 (1230-1310/ 1160-1175); capitulum 255 (260-275); chelicera 410-455 (430-455); genital field 240-255/205-235 (215-230/305-335); palp: trochanter 35-40 (40), femur 160-185 (165-180), genu 120-140 (120-140), tibia 190-245 (220-240), tarsus 60-65 (60-65); leg I: trochanter 90-120 (85-100), basifemur 190-200 (150-180), telofemur 250-295 (220-255), genu 435-485 (340-375), tibia 395-435 (340-380), tarsus 300-320 (265-300); leg IV: trochanter 230-255 (180-195), basifemur 290-325 (250-280), telofemur 395-435 (345-410), genu 525-585 (510-570), tibia 555-620 (515-560), tarsus 395-450 (370-410).

Etymology. The specific epithet is a noun in apposition taken from the name of the aboriginal tribe that originally inhabited the area of east Gippsland that includes the type locality (Tindale, 1940).

Remarks. Aspidiobates bidewel resembles *A. imamurai* K.O. Viets from New Caledonia in the type of sexual dimorphism of the dorsal shield, but males differ in the shape of the genu of leg IV and females by the relative sizes of the platelets of the dorsal shield. *Aspidiobates bidewel* is the largest known Australian species of the genus, but several species from New Caledonia are approximately the same size (Viets, 1968).

The female from the Yarra River is provisionally identified as this species, as it is slightly larger than the females from the type locality (it's measurements have not been incorporated in the description). Males are needed to confirm the identification.

Figures 1-4. *Aspidiobates bidewel* sp. nov. Holotype male: fig. 1, dorsal shield; fig. 2, ventral shield. Paratype female, K363: fig. 3, dorsal shield; fig. 4, ventral shield. Scale line = 500 μm.

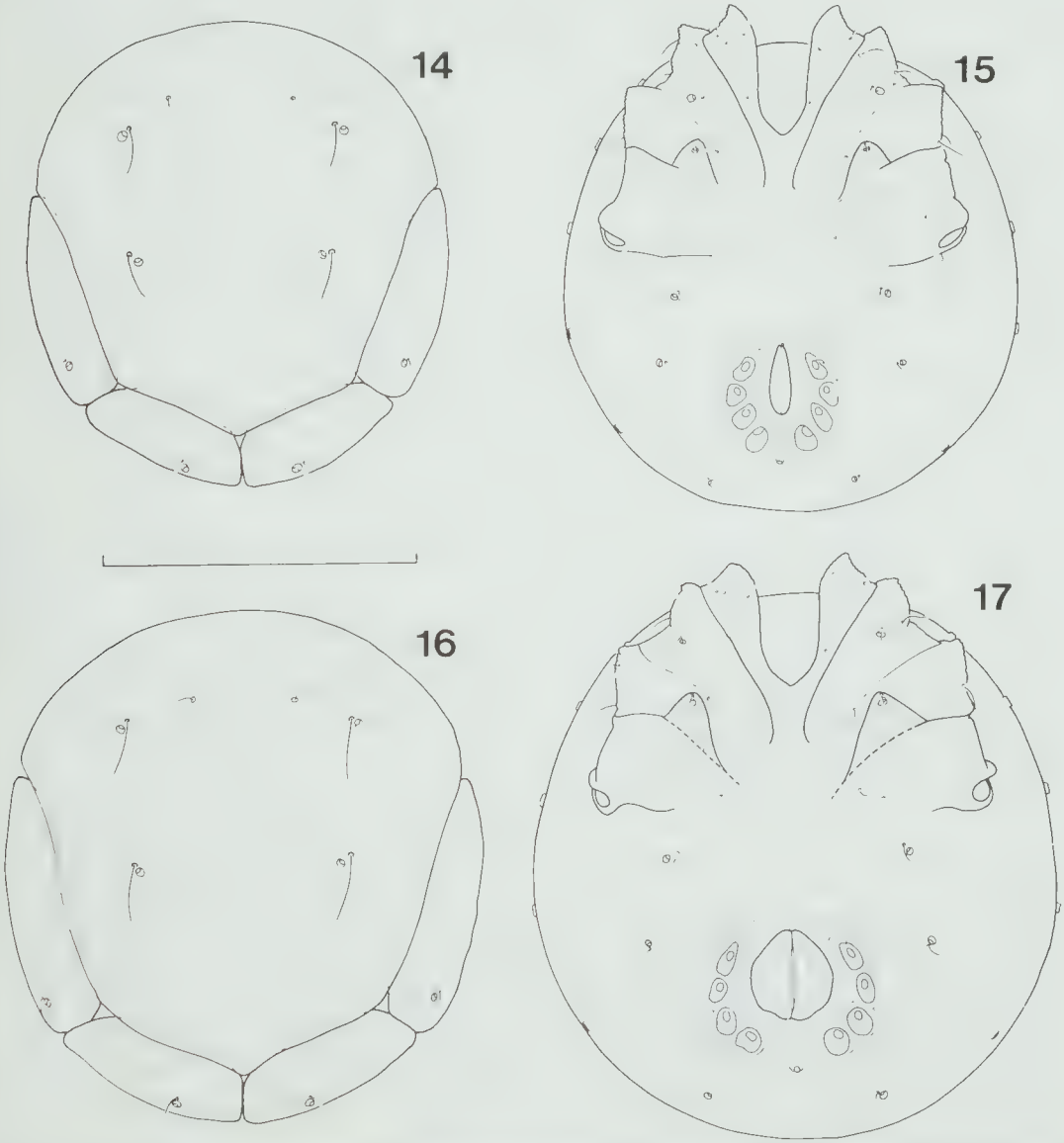


Figures 5-13. *Aspidiobates bidewel* sp. nov. Holotype male: fig. 5, genital field; fig. 6, right leg I; fig. 7, right leg IV; fig. 8, right genu IV. Paratype male, K355: fig. 9, left palp. Paratype female, K363: fig. 10, genital field; fig. 11, left palp; fig. 12, left leg I; fig. 13, left leg IV. Scale line = 200 μm (Figs. 5, 8-11), 500 μm (Figs. 6-7, 12-13).

Aspidiobates aethes sp. nov.
Figures 14-22

Type material. Holotype male, Victoria, Lyndon Flat, Barkly-Macalister junction (stn Mc14), 24 Feb 1978, NMV K372 (slide).

Paratypes: Victoria: same data as holotype, NMV K373-374, 2 males (slides). Caledonia River below junction of main branches (stn Mc6), 22 Feb 1978, NMV K375-378, 2 males, 2 females (fluid). Macalister-Caledonia River junction (stn Mc10), 24 Feb 1978, NMV K379-382, 1 male, 3 females (slides). Wellington River, 23.5 km NNE of Licola on Tamborine Road (stn Mc19), 24 Feb 1978, CNC, 1 male, 1 female (slides). Thomson River, 7 km NNW of Walhalla (stn T16), 6 Mar 1981, NMV K383, 1 male (slide). Aberfeldy River on Aberfeldy-Walhalla Road (stn T19), 16 Aug 1977, FMNH, 1 male (slide). Thomson-Aberfeldy River confluence, Fingerboard Spur Track (stn T20), 4 May 1977, FMNH, 1 female (slide). Thomson River, Forestry Track C6 (stn T21A), 3 Mar 1981, NMV K384, 1 female (slide). Mitta Mitta River, 2 km W of Dartmouth Dam Wall, 7 Mar 1977, NMV K385, 1 female (slide).



Figures 14-17. *Aspidiobates aethes* sp. nov. Holotype male: fig. 14, dorsal shield; fig. 15, ventral shield. Paratype female, K380: fig. 16, dorsal shield; fig. 17, ventral shield. Scale line = 500 μm.

Figures 18-22. *Aspidiobates aethes* sp. nov. Holotype male: fig. 18, genital field; fig. 19, left leg IV; fig. 20, left leg I. Paratype female, K380: fig. 21, genital field. Paratype male, K379: fig. 22, left palp. Scale line = 200 μm (Figs. 18, 21-22), 500 μm (Figs. 19-20).

Diagnosis. Genital field with four pairs of acetabula.

Description. Dorsal and ventral shields present; dorsal shield (Figs. 14, 16) similar in both sexes, with 2 pairs of narrow posteriorly placed platelets; large dorsal plate with 2 pairs of glandularia and the postocularia; postocularia and the first pair of glandularia placed relatively close to each other; ventral shield (Figs. 15, 17) with suture lines between third and fourth coxae extending anterolaterally at a moderate angle; glands of fourth coxae shifted onto the third coxae near the anterior suture lines of the third coxae; genital field with 4 pairs of acetabula (Figs. 18, 21), anterior pair slightly elongate; anus slightly posterior to genital field. Palp (Fig. 22): not sexually dimorphic. Legs (Figs. 19-20): swimming setae absent; not sexually dimorphic.

Dimensions (μm) male (female): Dorsal shield 715-795/680-730 (780-890/760-830), large dorsal plate length 635-700 (700-800), anterior platelet length 350-405 (385-465), posterior platelet length 260-295 (300-350), ventral shield 790-885/720-910 (920-1010/815-895); capitulum 179-189 (214); chelicera 269 (294-312); genital field 180-190/185-205 (195-215/280-330); palp: trochanter 30-35 (35), femur 120-125 (135-145), genu 90-95 (100-105), tibia 145-155 (170-180), tarsus 40-45 (45-55); leg I: trochanter 75-90 (80-85), basifemur 95-145 (100-115), telofemur 145-160 (140-165), genu 220-235 (205-260), tibia 220-240 (220-255), tarsus 140-180 (175-185); leg IV: trochanter 130-150 (135-160), basifemur 140-180 (155-165), telofemur 180-205 (200-230), genu 275-290 (295-305), tibia 295-315 (305-335), tarsus 225-235 (230-245).

Etymology. The specific epithet refers to the unusual number of acetabula (Greek *aethes* unusual, strange).

Remarks. Aspidiobates aethes most closely resembles *A. scutatus* Lundblad and *A. similis* Cook in

the shape and lack of sexual dimorphism of the dorsal shield, but differs from them by the possession of four pairs of acetabula.

Aspidiobates scutatus Lundblad

Aspidiobates scutatus Lundblad, 1941: 115.—Lundblad, 1947: 54-56, figs. 36a-e, pl. 26-27.—Cook, 1974: figs. 883, 886, 888.—Cook, 1986: 104-105, figs. 553-560.

Material examined. Victoria: Bald Hill Creek, 28 Apr 1975, NMV, 1 male, 1 female (fluid). Goanna Creek, 3 km N of Goongerah, D.R. Cook, M.S. Harvey and A.J. Boulton, 7 Apr 1985, NMV, 4 males, 11 females (slides and fluid). Lerderderg River, 4.8 km WNW of Blackwood, M.S. Harvey and R. St Clair, 8 Jan 1986, NMV, 1 male 1 female (fluid). Pinch Swamp Creek, 2 km E of Dellicknora, D.R. Cook, M.S. Harvey and A.J. Boulton, 8 Apr 1985, NMV, 2 males, 3 females (slides and fluid). Creek on Lyrebird Plain, Mt Buffalo National Park, M.S. Harvey and P. Lillywhite, 5 Dec 1985, NMV, 11 males, 8 females (fluid). Werribee River, 11.5 km NNW of Ballan, interstitial sample, A.J. Boulton, 2 Jun 1982, NMV, 1 female (fluid).

Remarks. Lundblad (1947) and Cook (1986) have recorded this species from one site in each of Tasmania, Victoria and New South Wales.

Aspidiobates similis Cook

Aspidiobates similis Cook, 1986: 105-106, figs. 545-552.

Material examined. Victoria: Lerderderg River, 3.8 km WNW of Blackwood, A.J. Boulton, 22 Aug 1982, NMV, 2 females (fluid). Same data except 7 Jun 1983, NMV, 2 females (fluid). Lerderderg River, 4.8 km WNW of Blackwood, R. St Clair, 2 May 1985, NMV, 1 female (slide). Same data except 5 Jun 1985, NMV, 1 male, 2 females (fluid). Same data except 5 Jul 1985, NMV, 1 male (fluid). Same data except M.S. Harvey and R. St Clair, 8 Jan 1986, NMV, 37 males, 62 females, 8 deutonymphs (slides and fluid).

Remarks. Initially described from Tasmania by Cook (1986), this is the first record of *A. similis* from mainland Australia where it has been taken only in the Lerderderg River.

Aspidiobates geometricus Cook

Aspidiobates geometricus Cook, 1986: 106-107, figs. 561-569.

Material examined. Victoria: Sandy Waterhole Creek, Genoa, 37°23'S, 149°26'E, 24 Feb 1976, NMV, 1 male (slide).

Remarks. This is the first record of this species from Victoria, which was originally described from New South Wales and Queensland.

Acknowledgements

We wish to thank Ros St Clair and Andrew Boulton for donating specimens or assisting in the collection of material, Dr I.M.Smith for sending us the Thomson River material he identified for Malipatil and Blyth (1982), John Blyth for support, the National Parks and Wildlife Service for allowing work to be undertaken in Mount Buffalo National Park, and the Australian Biological Resources Study for financial support.

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Correction

Memoirs of the Museum of Victoria volume 48, number 2 (1987)

M. S. Harvey. *Grymeus*, a new genus of pouched oonopid spider from Australia (Chelicerata: Aranae)

On page 127 the list of paratypes of *Grymeus yanga* Harvey from New South Wales should read:

New South Wales, Yanga Lake (34°42'S, 143°35'E), under bark of *E. camaldulensis*, T. Weir, 16 May 1984, ANIC (1♂). Yanga Creek, (34°42'S, 143°35'E), under bark of *E. camaldulensis*, D.C.F. Rentz and M.S. Harvey, 24 Oct 1983, ANIC (1♀).

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TAXONOMIC STATUS OF VICTORIAN FOSSIL WHALES ASSIGNED TO THE GENUS *CETOTOLITES* McCOY, 1879

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Abstract

Fordyce, R.E., 1988. Taxonomic status of Victorian fossil whales assigned to the genus *Cetotolites* McCoy, 1879. *Memoirs of the Museum of Victoria* 49: 59-65.

McCoy used the generic name *Cetotolites* McCoy, 1879 in the sense of a collective group genus in the Cetacea, thus formalising the name which Owen (1844, 1846) had proposed as a vernacular for isolated cetacean earbones. McCoy assigned to the genus three new species of fossil Cetacea (*Cetotolites leggei; C. pricei; C. nelsoni*) based on Late Oligocene tympanic bullae from Waurn Ponds, Victoria, Australia. Lectotypes are established here for the species. All the type specimens are incomplete, and are probably undiagnostic at the species level. The bulla of *Cetotolites nelsoni* is similar to that of the primitive toothed mysticete *Mammalodon colliveri* Pritchard, 1939, but it is not certainly conspecific. The names *Cetotolites leggei, C. pricei, C. nelsoni* and *nelsoni rugosa* are considered here to be *nomina dubia*.

Worn isolated fragments of fossil Cetacea should not be used as type specimens, since they generally lack synapomorphies. Many long established names based on such material should probably be discarded, since it is impossible to demonstrate their conspecificity with more-complete specimens.

Introduction

Tympanic bullae referred to species of the genus *Cetotolites* McCoy,1879, were among the many specimens of Victorian fossil Cetacea (whales, dolphins and porpoises) described by Frederick McCoy. McCoy (1879) established four new species and subspecies of *Cetotolites* on the basis of worn and polished tympanic bullae from the Jan Juc Formation at Waurn Ponds, near Geelong, Victoria. Subsequently, McCoy's names have been cited in the literature without comment on their status. I suggest in this article that none of the type specimens of *Cetotolites* species possesses characteristics which allow recognition of its zoological species and, thus, that the names are *nomina dubia*.

The term "cetotolites" (Greek: *ketos*, whale; *otos*, of the ear; *lithos*, stone) was used by Richard Owen (1844; 1846: 526-535; 1870) and a few contemporary authors as a vernacular name for fossil tympanic bullae and periotics of Cetacea. Owen did not employ the name in a binomen; indeed, McCoy appears to be the only person to have proposed such a binomen formally. McCoy (1879) noted that Owen had used the vernacular name "cetotolites" for isolated earbones which Owen himself had referred to previously established formal taxa. McCoy observed that it is difficult to determine the true relationships of isolated bullae such as the Waurn Ponds specimens, and proposed that the name *Cetotolites* be used as a formal generic name (in the modern sense of the collective group of genus rank) to encompass species based on isolated elements. McCoy believed that, although the true relationships of his proposed species of *Cetotolites* could not be determined, they probably represented species of "ziphioid" (sic) whales (Family Ziphiidae—beaked whales) which he supposed were represented by other fossils from Waurn Ponds.

Later authors have not discussed the validity of McCoy's species of *Cetotolites* nor proposed any new species, although the species have been mentioned in various published tables of Victorian fossils. The only comments on the systematics of *Cetotolites* species appear to be those of Mahoney and Ride (1975: 158, 164-167) who listed the species, type specimens, and collection data, and Fordyce (1982; 1984: table 1) who alluded to the possibly undiagnostic type specimens.

Complete redescriptions of the type specimens of *Cetotolites* species are not given here. Adequate, if somewhat antiquated, descriptions were given by

McCoy (1879) in his illustrated text. The type specimens are figured here (Figs. 1-6, 9, 10). Morphological nomenclature follows Kasuya (1973).

The generic name *Cetotolites*

McCoy (1879) did not specify a type species for the genus *Cetotolites*. He commented about this nominal genus (McCoy, 1879: 13-14): "As . . . I do not think it is possible satisfactorily to refer them to their true genera from such materials I propose to use provisionally the word Cetotolites as a generic term for such fossil Cetacean Ear-bones as I have to describe". In stating this, McCoy appears to have proposed that the name *Cetotolites* be used in the sense of a collective group. Collective groups require no type species (International Commission of Zoological Nomenclature [referred to hereinafter as the *Code*] 1985, Article 42b (i)), so the name *Cetotolites* cannot be a *nomen dubium* despite the lack of an originally-designated type species or the fact that the four species and subspecies of *Cetotolites* named by McCoy are considered herein to be *nomina dubia*.

The species of *Cetotolites*

McCoy (1879) presented formal descriptions for four species and subspecies of *Cetotolites*. A fifth species, *C. baileyi* was mentioned by McCoy (1883), but this was never described, defined, or accompanied by an indication. It is thus a *nomen nudum* (*Code*, Article 12). *Cetotolites baileyi* should not be confused with the fossil sperm whale *Physetodon baileyi* McCoy, 1879, which is based on teeth of probable Late Miocene age from near Beaumaris, Victoria (Fordyce, 1982; 1984).

McCoy (1879) indicated that he based *Cetotolites leggei, C. pricei* and *C. nelsoni* on a least 18 specimens, but only the five illustrated by McCoy (1879: pl. LIV) can be identified in the collections of the Museum of Victoria. At least 11 other Museum specimens are identified by attached labels, accompanying labels, or catalogue entries, as belonging to these three species. Some or all of these may be other syntypes available to McCoy during preparation of the 1879 article but, because there is no positive evidence of this, the type status of these 11 specimens is uncertain. Thus, they can and must be ignored during consideration of the nomenclatural status of *Cetotolites* species.

McCoy indicated that all specimens mentioned by him in 1879 came from Waurn Ponds Quarries, near Geelong, Victoria. This is not disputed as the locality for the five figured specimens (McCoy, 1879: pl. LIV) nor the four other specimens (P7457, P7458, P7459, P26523) which bear attached labels indicating Waurn Ponds as the locality. Waurn Ponds is given on the separate labels of seven other specimens. Two quarries, which are potential type localities, are at grid references BT613673 and BT611682 (1: 100 000 map, Series R 652, Sheet 7721, Geelong), or about 38°16′S, 144°16′E. Mahoney and Ride (1975: 163-164) gave further information about this locality. The type specimens probably came from the Waurn Ponds Member of the Jan Juc Formation (Torquay Group) which, according to Abele et al. (1976: fig. 13) is of Late Oligocene to earliest Miocene age.

Cetotolites leggei

Only two specimens (syntypes, according to Mahoney and Ride, 1975: 164) were mentioned by McCoy (1879: 14-15), and only two specimens are identifiable in the Museum collections. I designate specimen P7449 (a right bulla; McCoy, 1879: pl. LIV figs. 1, 1a) the lectotype of the nominal species *C. leggei*. It is not known if P7450 (a left bulla) is the second syntype mentioned by McCoy. Specimens P7449 and P7450 may be specimens 30431 and 30432 of an early Museum register (Mahoney and Ride, 1975).

The lectotype (P7449; Figs. 1, 2) lacks the anterior part of the involucrum, all of the dorsal part of the thin outer lip (including the anterior pedicle and accessory ossicle, base of the malleus, sigmoid process, conical process, and outer posterior pedicle); all these structures should normally be studied if one is to determine relationships from isolated bullae of Cetacea. The bulla is worn and polished, and much of the original surface is lost.

The absence of marked inner and outer prominences (typically separated by a marked interprominential notch) and of a ventral median groove suggest that the specimen is not related closely to modern odontocete groups, such as the delphinoids. It agrees with some physeterids in the absence of an interprominential notch, but this character may be convergent; physeterids are more derived in other features. Indeed, the large size and robust structure of the bulla argues against close relationship with any known odontocete. Its features are reminiscent of those of some archaeocetes and mysticetes (e.g. *Dorudon*, see Kellogg, 1936: fig. 80; *Mauicetus*, see Marples, 1956) but, as these may be shared primitive features, they indicate little about relationships. The deep posterior portion of the tympanic cavity, which is succeeded anteriorly by a smoothly elevated ridge, is more reminiscent of known odontocetes than of archaeocetes or mysticetes. Its significance is difficult to interpret.

Because this lectotype lacks any features at present recognisably diagnostic below the ordinal level, I suggest that the name *Cetotolites leggei* is a *nomen dubium* and that the nominal taxon can only be treated as Cetacea *indet.* The lectotype (P7449) and another specimen (P7450) identified as *C. leggei* are too incomplete to decide whether they are conspecific.

Cetotolites pricei

McCoy (1879: 16) stated that this species is "much more abundant" than *C. leggei* and that "several" specimens had been brought to the Museum. Mahoney and Ride (1975: 167) reported only one specimen (P7451, a right bulla), but two other specimens (P7452, a right bulla and P7453, a left bulla) identified by label as *C. pricei* are in the Museum collections. I designate specimen P7451 (McCoy, 1879: pl. LIV, Figs. 2, 2a) as the lectotype of the nominal species *C. pricei.* It is not known if the two other specimens were part of McCoy's type series. Specimens P7451, P7452, and P7453 may be specimens 30433, 30434 and 30435 respectively of the early Museum register (Mahoney and Ride, 1975).

The lectotype (P7451; Figs. 3, 4) is more complete than that of *C. leggei* in that more of the floor of the tympanic cavity and more of outer lip are preserved. The anterointernal face of the involucrum and the apex of the bulla are worn, and the original profiles are uncertain. This bulla is too incomplete and weathered to be certain of its affinities. The ventral median groove is more conspicuous than in P7449, and the relatively unworn posterior part of the involucrum differs in shape, but whether this reflects original morphological differences or erosion cannot be determined. It is not possible to say to which of the three cetacean suborders (Archaeoceti, Mysticeti and Odontoceti) the specimen should be referred, but the relatively large size argues against odontocete affinities.

Because this lectotype lacks any features at present recognisably diagnostic below the ordinal level, I suggest that the name *Cetotolites pricei* is a *nomen dubium* and that the nominal taxon can only be treated as Cetacea *indet.* The relationships (conspecific or congeneric) of referred specimens P7452 and P7453 to the lectotype cannot be determined, as all specimens are too incomplete.

Cetotolites nelsoni

McCoy (1879: 17) stated that 14 specimens were in the Museum, including not more than 13 syntypes of *Cetotolites nelsoni* (sensu stricto; referred to hereinafter without a subspecific epithet) and the holotype and possibly other specimens of *Cetotolites nelsoni rugosa* (see Mahoney and Ride, 1975: 166). Eleven specimens identified as *C. nelsoni* (sensu lato) are presently in the Museum. McCoy (1879: pl. LIV) figured two of these (P7454, a left bulla, McCoy's Figs. 3, 3a, 3b; and P7456, a right bulla, McCoy's Fig. 5). I designate specimen P7454 as the lectotype of the nominal subspecies *C. nelsoni nelsoni.* Specimen P7456 is designated a paralectotype. Mahoney and Ride (1975) identified specimen P7455 (a right bulla, McCoy's Figs. 4, 4a) as the holotype of the nominal subspecies *Cetotolites nelsoni rugosa.* The remaining eight specimens, labelled as *Cetotolites nelsoni* (subspecies unspecified) are possible paralectotypes, but it is not certain that they were part of McCoy's original type-series. These specimens are P7457 (right bulla), P7458 (left bulla), P7459 (left bulla), P7460 (left bulla), P7461 (right bulla), P7462 (left bulla), P7463 (left bulla), P26253 (left bulla). Specimen labels indicate that specimens P7457 to P7463 are specimens 30439 to 30445 respectively of the early Museum register.

The lectotype of *Cetotolites nelsoni* (Figs. 5, 6) is preserved poorly, with the dorsal edge of the thin external lip incomplete and the surface markedly weathered. Thus, its affinities are uncertain. Its relatively small size, conspicuous interprominential notch, outer posterior prominence and ventral median groove, and large tympanic cavity are odontocete-like, while the absence of a depression for the exit of the eustachian tube at the anterior end of the tympanic cavity, the elongate tabular dorsointernal face of the anterior part of the involucrum, and the relatively deep notch between the position of the inner and outer posterior pedicles could be interpreted as mysticete features.

The lectotype bulla (P7454) of *C. nelsoni* is similar to the hitherto undescribed bulla of the holotype of *Mammalodon colliveri* Pritchard, 1939 (Melbourne University, Geology Department MUGD 1874). *Mammalodon colliveri* is a latest Oligocene primitive toothed mysticete (Fordyce, 1982; 1984) which appears to be a relict species broadly representative of the earliest stages of evolution of baleen whales. The holotype was collected from Bird Rock, Torquay, Victoria, less than 15 km from Waurn Ponds quarries. It came from the uppermost Jan Juc Formation, which is laterally equivalent to the Waurn Ponds Limestone whence the lectotype of *C. nelsoni* was obtained; thus, the two specimens are roughly contemporaneous. The bullae (Figs. 7, 8) are both 53 mm long (length from anterior apex to the apex of the inner prominence), and both show the following features: relatively large elongate tabular dorsointernal face on anterior part of involucrum; steep external face on

anterior of involucrum; abrupt inflection between anterior edge of external lip and internal edge of involucrum; broadly rounded transverse ridge between anterior and posterior portions of tympanic cavity; dorsal surface of involucrum which rises abruptly behind its midpoint; concave profile of middle of internal face of involucrum (dorsal view); smoothly rounded inner posterior prominence (dorsal view); shallow interprominential notch; outer posterior prominence extends further posteriorly than inner; and deep cleft in position of elliptical foramen between inner and outer posterior pedicles. The bulla of *M. colliveri* differs from that of *C. nelsoni* in a rugose dorsal surface on the involucrum, rugosities on the floor of the tympanic cavity, a more rounded anterior profile of the external lip, a deeper and longer ventral median groove, and a flatter anterior ventral surface. These differences may reflect growth, postmortem wear, or interspecific differences. In my opinion it is not certain that the specimens are conspecific. The similarities do not necessarily mean conspecificity, since different species and genera of extant Cetacea may possess apparently identical bullae (Kasuya, 1973). Indeed, some of the features seen *C. nelsoni* are also present in bullae of Late Oligocene odontocetes.

Because the lectotype of *C. nelsoni* lacks any features at present recognisably diagnostic below the ordinal level I suggest that the name *Cetotolites nelsoni* is a *nomen dubium* and that the nominal taxon can only be treated as Cetacea *indet*. Since none of the other specimens of the type-series of *Cetotolites nelsoni* (sensu lato) is certainly conspecific with the lectotype, none clarifies the relationships of the species.

Cetotolites nelsoni rugosa

The holotype of *Cetotolites nelsoni rugosa* (P7455; Fig. 9) differs from the lectotype of *Cetotolites nelsoni nelsoni* in that the floor of the tympanic cavity is more rugose, and the interprominential notch, outer posterior prominence, and ventral median groove are more pronounced. Specimens P7454 and P7455 are so incomplete and eroded that it is impossible to say whether differences between them are ontogenetic or taxonomic. I suggest that the name *Cetotolites nelsoni rugosa* is a *nomen dubium* and that the nominal taxon can only be treated as Cetacea *indet.*

Discussion

This article uses the following assumptions about taxonomy which have been discussed widely in recent literature on cladistics (e.g. Ridley, 1986, and references therein), but which are not accepted in total by all taxonomists:

1. A classification scheme should reflect real (evolutionary) relationships between its consistituent taxa.

2. The primary aim of taxonomic names is to express such relationships; only secondarily do taxonomic names aid communication between taxonomists.

3. Evolutionary relationships between taxa can be assessed only in terms of shared evolutionary novelties, and it follows that any specimen too incomplete for low level synapomorphies to be identified cannot be classified to low taxonomic rank. Despite the fact that palaeontologists generally have less complete material to work with than neontologists, palaeontologists dealing with fossils that belong in an extant higher taxon should not expect nor be accorded more taxonomic latitude than that accorded to neontologists.

4. If the type specimens of long-established nominal species are particularly incomplete, nonmorphological criteria (e.g. geographic distribution, stratigraphic age, inferred ecology) should not be invoked to bolster the name, as such criteria introduce too many assumptions; rather, names of debatable application are dealt with best through the powers of the International Commission on Zoological Nomenclature.

Given these assumptions, I suggest that older names based on inadequate types should not be conserved at any cost; any short term instability in nomenclature which results from abandoning ill-defined names can only be to the benefit of long term stability. I also suggest that collective group names have no value in expressing real relationships within a classification scheme and that, if proposed as an aid to communication, they may be misleading. Any specimen which is too incomplete to be determined to low taxonomic rank (e.g. genus or species level) might usefully be described as an indeterminate taxon within a known higher taxon; I have followed this approach in my own work on cetacean taxonomy (e.g. Fordyce, 1983). In my opinion, it is unfortunate that many taxonomists consider it necessary for a specimen to be identifiable to species level before a formal published description is warranted.

More specifically, I suggest that McCoy's (1879) names should not be brought into modern use, and that other material should not be referred to the genus *Cetotolites*. The continued use of collective groups such as *Cetotolites* McCoy, 1879, and *Mizuhoptera* Hatai, Hayasaka and Masuda, 1963,

hinders rather than advances knowledge of cetacean systematics.

Tympanic bullae have been and still are used widely in cetacean taxonomy. However, there are few cases, even amongst extant species, in which the tympanic bulla alone can give an accurate idea of relationships at all taxonomic ranks down to species level. Much of the documented taxonomic variation in cetacean bullae appears to be variation in degree, rather than in kind, of superficially simple morphology. This, and the difficulty in identifying homologous features on bullae of different members of clades, has generally prevented the identification of primitive versus derived states. Accordingly, assessments of relationships that use bullae depend on the often-subjective basis of overall similarity, rather than on the more objective basis of the identification of synapomorphies. This makes it difficult to assess the taxonomic importance of any given character or the presence of convergence. In part, these problems reflect the fact that the functional morphology of the tympanic bulla is understood poorly. There appears to be no case where bullar functional morphology in any cetacean species has been correlated with a taxonomically-specific acoustic behaviour which, in turn, is linked to evolutionary-ecological adaptations. Similarly, it seems that there are no examples of correlations between bullar functional morphology and structure of the periotic and skull in any one species, although there are rough correlations at higher taxonomic levels. Pioneering articles by Kasuya (1973) and Fleischer (1973, 1976) on odontocetes have elucidated some of these problems. Because of the problems involved in systematics based on the bullae of extant Cetacea, it is difficult to work with fossil bullae. For this reason, I contend that names of *Cetotolites* species are *nomina dubia* and strongly support the suggestion of Barnes (1977) that isolated fossil bullae not be used as type specimens.

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Explanation of plate

Figures 1, 2—*Cetotolites leggei*, lectotype, right tympanic bulla, P7449, × 1. Figure 1—dorsal view. Figure 2—Ventral view.

Figures 3, 4—*Cetotolites pricei*, lectotype, right tympanic bulla, P7451, × 1. Figure 3—dorsal view. Figure 4—ventral view.

Figures 5, 6—*Cetotolites nelsoni*, lectotype, left tympanic bulla, P7454, × 1. Figure 5—dorsal view. Figure 6—ventral view.

Figures 7, 8—*Mammalodon colliveri*, holotype, right tympanic bulla, MUGD 1874, × 1. Figure 7—dorsal view. Figure 8—ventral view.

Figure 9—*Cetotolites nelsoni rugosa*, holotype, right tympanic bulla, P7455, × 1. Dorsal view.

Figure 10—*Cetotolites nelsoni*, paralectotype, right tympanic bulla, P7456, × 1. Dorsal view.


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THE REDISCOVERY OF *PAGURUS ACANTHOLEPIS* (STIMPSON) (DECAPODA: ANOMURA: PAGURIDAE)

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Abstract

Gunn, S.W. and McLaughlin, P.A., 1988. The rediscovery of *Pagurus acantholepis* (Stimpson) (Decapoda: Anomura: Paguridae). *Memoirs of the Museum of Victoria* 49: 67-71

The discovery of males of *Pagurus acantholepis* (Stimpson) has shown that this species was incorrectly assigned to *Pagurus*. It is redescribed, illustrated and reassigned to *Micropagurus* McLaughlin as herein emended. This species has also been found to be the senior synonym of *Anapagurus australiensis* Henderson. Henderson's male syntype is designated the neotype of *Eupagurus acantholepis* Stimpson.

Introduction

During surveys of the fauna of coastal waters of Victoria and of Bass Strait, Australia, by members of the Marine Research Group associated with the Museum of Victoria, a few specimens of a hermit crab species apparently referable to *Pagurus acantholepis* (Stimpson) were collected. However, the presence of a sexual tube in the males indicated that these specimens could not be correctly assigned to *Pagurus*. Stimpson's (1858) description of *Eupagurus acantholepis*, published in a preliminary account of the decapod crustaceans collected during the North Pacific Exploring Expedition of 1853-1856, was based on a single female from Port Jackson, New South Wales. The subsequent final report of the Expedition, although prepared by Stimpson before his death in 1872, was not published until 35 years later (cf. M. Rathbun, 1907). The two descriptions of *Pagurus acantholepis* are essentially the same; however, in the latter publication Stimpson (1907) remarked that his species presented some "peculiarities" which might require its removal from *Pagurus* and that knowledge of the male was desirable. The only other published reports of this species are the bibliographic references of Alcock (1905) and Gordan (1956).

The type of *P. acantholepis* was undoubtedly destroyed in the 1871 fire at the Chicago Academy of Sciences where Stimpson's collections were housed (cf. R. Rathbun, 1883). However, there is sufficient agreement between Stimpson's (1858, 1907) descriptions and the Victorian specimens, particularly in the development of multispinose ocular acicles and prominent interocular lobes ("bifurcated bracteole" of Stimpson) to convince us that they do represent Stimpson's taxon.

Henderson (1888) also described a pagurid species from Port Jackson, which possessed multispinose ocular acicles and a male left sexual tube. An examination of the syntypes of Henderson's *Anapagurus australiensis* has shown that prominent interocular lobes are similarly developed in this taxon and in all other characters it also agrees with the Victorian specimens. Thus we believe that Stimpson's (1858) *Eupagurus acantholepis* is the senior synonym of *Anapagurus australiensis*. In the interest of nomenclatorial stability we herein designate the male syntype of Henderson's *A. australiensis* as the neotype of *E. acantholepis*.

McLaughlin (1986) described a new monotypic Hawaiian genus, *Micropagurus*, that she related to *Anapagurus* and *Spiropagurus* because of the similar development of the male left sexual tube. However, she differentiated *Micropagurus* from the other two genera by the presence of multispinose ocular acicles; a telson lacking a transverse suture but with the terminal margin entire; and the absence of the male right gonopore. In her discussion, McLaughlin noted that both *Anapagurus australiensis* and *A. polynesiensis* Nobili pos-

sessed multispinose ocular acicles and the latter species, at least, lacked the male right gonopore (cf. de Saint Laurent, 1968) thus both might also be referable to *Micropagurus*. Subsequently, Haig and Ball (in press) did assign both species to *Micropagurus*. In her generic diagnosis, McLaughlin (1986) did not mention the presence of interocular lobes; however, she did figure these structures in *M. devaneyi* McLaughlin (fig. 4a).

As previously indicated, the presence of a male sexual tube in Stimpson's (1858) taxon excludes it from *Pagurus*. In all characters, except the absence of the male right gonopore, this Australian species agrees with *Micropagurus*. Although intrageneric and/or intraspecific variation in male gonopore development has not been reported in paguroids, such variation in female gonopores occurs in species of *Paguristes* (cf. Forest, 1954; de Saint Laurent, 1968), *Diogenes* (Tirmizi and Siddiqui, 1982) and *Pagurixus* (de Saint Laurent, 1968; McLaughlin and Haig, 1984). Therefore, in our opinion, the single character, presence or absence of the male right gonopore does not justify the erection of two genera that in all other characters appear identical. It is preferable that *Micropagurus* be emended to include species in which the right gonopore may be developed in the male. As interocular lobes ["écailles" of Bouvier (1896)] have also been reported in *Anapagurus bicorniger* A. Milne Edwards and Bouvier and *Anapagurus petiti* Dechance and Forest (cf. Bouvier, 1940; Dechance and Forest, 1962; Garcia Raso, 1982), the characters most useful for separating species of *Micropagurus* from species of *Anapagurus* are the configuration of the telson and armature of the ocular acicles.

Micropagurus acantholepis (Stimpson) comb. nov.

Figure 1

Eupagurus acantholepis Stimpson, 1858: 251.—Stimpson, 1907: 229.

Anapagurus australiensis Henderson, 1888: 74, pl. 7, fig. 8.

Pagurus acantholepis.—Rathbun, 1907: 229 (footnote).

Type material. Neotype (herein selected): male syntype of *Anapagurus australiensis*, SL = 1.7 mm, British Museum (Natural History) 1888:33, HMS "Challenger", 3.6-18 metres, Port Jackson, New South Wales, Australia.

Female syntype of *Anapagurus australiensis*, SL = 1.8 mm, BMNH 1888:33, HMS "Challenger", 3.6-18 metres, Port Jackson, New South Wales, Australia.

Other material. Victoria. Honeysuckle Point, Western Port (38°26′S, 145°04′E), intertidal rock platform, S.W. Gunn, 26 Nov 1986, NMV J14231 (1 male); 11 Nov 1902, NMV J14233 (1 male); S.W. Gunn, 17 Feb 1985, NMV J12185 (1 male). Eagles Nest, near Inverloch (38°40′S, 145°41′E), intertidal rock platform, S.W. Gunn, 26 Nov 1985, NMV J14232 (1 male). Port Phillip Bay, no details, NMV J12177 (1 male). Port Phillip Bay, Port Phillip Heads region (38°16′S, 144°41′E to 38°20′S, 144°51′), 8-12.5 m, dredged, Marine Research Group, Mar 1986 to Apr 1987, NMV J14558 (5 females), J14559 (1 male, 1 female), J14560 (6 males, 1 female), US Museum of Natural History 234302 (1 male, 1 female), Allan Hancock Foundation 2778-01 (1 male, 1 female), Australian Museum, Sydney P37799 (1 male, 1 female). Point Lonsdale (38°17′S, 144°37′E), intertidal, Marine Research Group, 12 Mar 1987, NMV J14561 (1 male).

South Australia, Spalding Cove, Port Lincoln, 47 m, 5 Nov 1969, NMV J14566 (1 male).

Description. Shield considerably longer than broad; anterior margin between rostrum and lateral projections concave; posterior margin truncate. Rostrum broadly rounded, little if any in advance of lateral projections, unarmed or with tiny spinule laterally. Lateral projections broadly rounded, unarmed. Ocular peduncles two-thirds to three-quarters length of shield, slightly inflated basally and in corneal region, dorsomesial surface with widely spaced tufts of short setae. Ocular acicles with 3-4 (rarely 1) marginal spines; separated by slightly less than basal width of 1 acicle. Interocular lobes prominent, chitinous or weakly calcified, and with few setae. Antennular peduncles reaching bases of corneae or only slightly beyond; ultimate and penultimate segments with few setae; basal segment with unarmed protuberance on dorsolateral distal angle. Antennal peduncles not overreaching ocular peduncles; with supernumerary segmentation; fifth and fourth segments with scattered setae; third segment with spine at ventral margin; second segment with dorsolateral distal angle produced, terminating in strong simple or bifid spine, dorsomesial distal angle with small spine; first segment with small spine on lateral margin and well developed spine on produced ventral margin. Antennal acicle short, slightly arcuate, terminating in small spine; mesial margin with tufts of setae. Antennal flagella short, with 1 or 2 moderately short and occasionally 1 or 2 longer setae every 1 or 2 articles. Third maxilliped with well developed crista dentata provided with 1 accessory tooth; merus and carpus each with prominent dorsodistal spine. Sternite of third maxillipeds unarmed. Sternite of 3rd pereopods subrectangular. Sternite of fifth pereopods with 2 asymmetrical, widely separated lobes, each with few terminal setae.

Right cheliped with dactyl approximately two-thirds length of palm; cutting edge with 1 or 2 prominent calcareous teeth proximally, sometimes

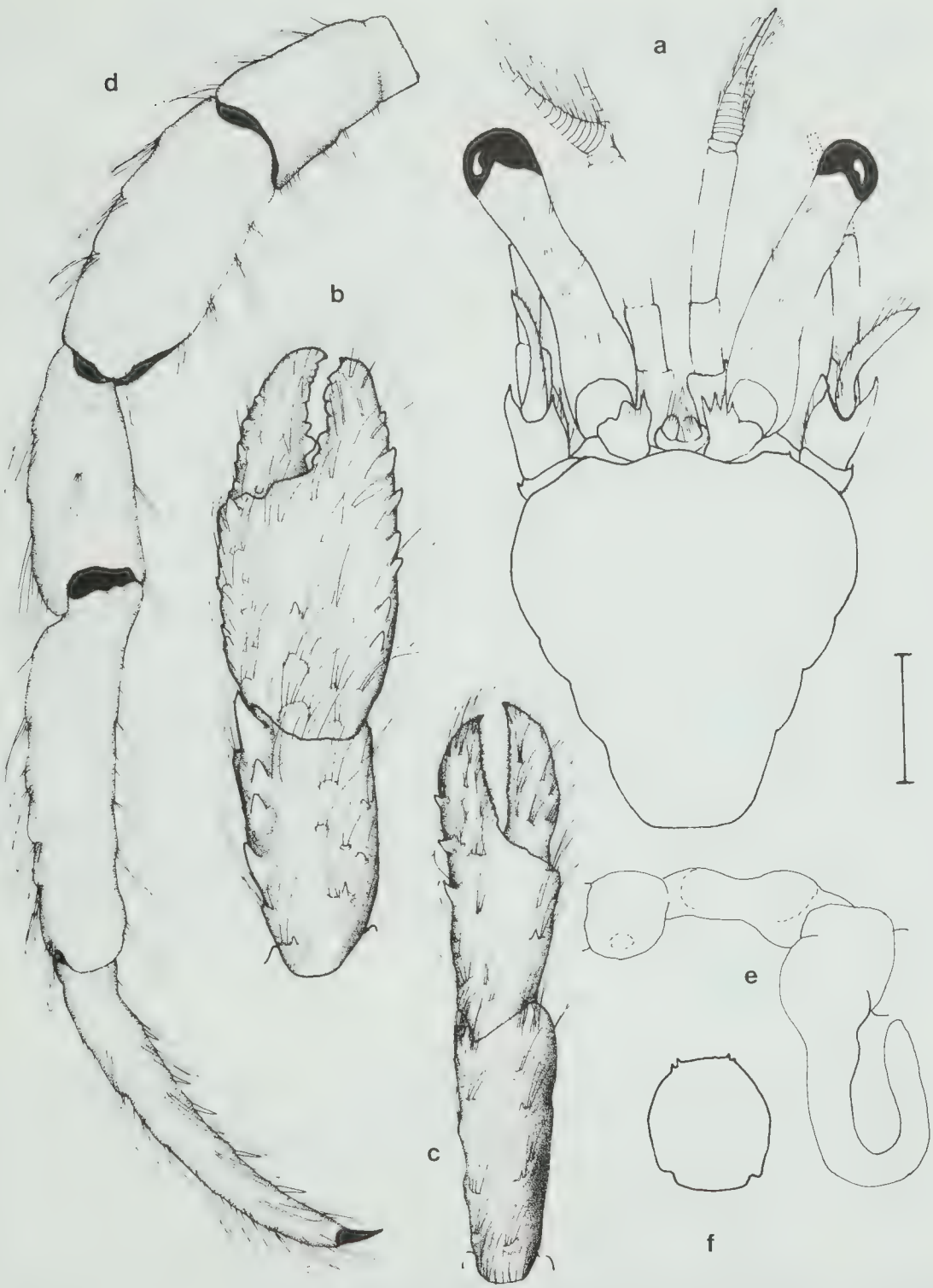

Figure 1. *Micropagurus acantholepis* (Stimpson), male, Port Phillip Bay, Victoria, J12177. a, shield and cephalic appendages; b, right chela and carpus; c, left chela and carpus; d, left third pereopod (lateral view); e, coxae and sternite of fifth pereopods illustrating male left sexual tube; f, telson. Scale = 1 mm.

separated by 1 smaller tooth, few small calcareous teeth distally; slightly overlapped by fixed finger; dorsomesial margin with 2 or 3 spines proximally and occasionally 1 small spinule at proximal angle; few scattered setae on all surfaces. Palm slightly shorter than carpus; dorsomesial margin with 1-4 spines proximally separated from single distal spine by broad space, dorsal surface with 2 spines or tubercles proximally and 1 medially, dorsolateral margin with row of widely spaced spines extending onto proximal half of fixed finger; all surfaces with scattered short to moderately long setae. Carpus approximately equal to length of merus; dorsomesial margin usually with 2 to 4 strong spines distally and smaller spine in proximal half, occasionally only protuberances, dorsal surface with 1 or 2 protuberances or spines distolaterally transverse ridges extending onto lateral face, occasionally with spine on lateral face in proximal half. Surfaces all with scattered setae. Merus with slight protuberance proximally on ventromesial margin and distally on ventrolateral margin; and with scattered setae dorsally and ventrally.

Left cheliped only slightly shorter than right; dactyl as long as or slightly longer than palm, unarmed but with scattered setae on all surfaces. Palm approximately half length of carpus; slightly protuberant in midline proximally and occasionally armed with single spine; dorsomesial margin with 1 or 2 spines proximally and frequently low protuberances distally; dorsolateral margin with few widely-spaced spines sometimes extending onto fixed finger; surfaces with scattered setae. Carpus shorter than merus; dorsolateral margin with row of 3 or 4 spines, dorsomesial margin with low protuberances and/or spines; tufts of setae often arising from low, occasionally spinulose, protuberances on mesial, lateral and ventral surfaces. Merus with low protuberance on ventromesial margin proximally and tufts of setae distally and ventrally.

Ambulatory legs similar in armament and ornamentation. Dactyls as long or slightly longer than propodi, each terminating in moderately strong, corneous claw; dorsal margins and mesial faces each with row(s) of moderately long setae; ventral margins each with row of 5-9 widely spaced corneous spines, sometimes not reaching to base of claw. Propodi approximately twice length of carpi; unarmed but with protuberances from which tufts of setae arise. Carpi slightly shorter than meri; unarmed but with well developed protuberances and tufts of setae, particularly on dorsal margins. Meri unarmed but with dorsal and ventral protuberances and tufts of setae. Propodal rasp of fourth pereopod with 2 or 3 rows of corneous scales; dactyl with very small terminal claw and apparently no preungual process.

Male with coxa of fifth left pereopod slightly to considerably larger than right, with well developed sexual tube recurved upward to level of coxa of fifth pereopod. Coxa of fifth right pereopod with gonopore on posteroventral surface. Pleopods 3-5 uniramous or occasionally biramous. Female with paired gonopores, 4 unpaired pleopods, pleopods 2-4 unequally biramous, pleopod 5 uniramous. Uropods extremely assymetrical, with right exopod approximately equal in size to left endopod. Telson without transverse suture; terminal margin entire with 1-3 tiny spinules on each side laterally.

Colour. The limited number of specimens so far available indicates a wide range of coloration. A freshly taken specimen reveals a shield and anterior projections flamed and mottled with red and brown, with overall background colour yellowish. The pale ocular peduncles have short, oblique brown markings and the corneae are almost colourless. A very old specimen in alcohol has brown ocular peduncles which have large white circles.

Distribution. New South Wales: Port Jackson; Victoria: Port Phillip Bay, Western Port, central coast; South Australia: Port Lincoln.

Remarks. The presence of a right male gonopore distinguishes *M. acantholepis* from both *M. devaneyi* and *M. polynesiensis.* In addition, the lack of armature on the dorsal surfaces of the pereopods is a character that can used to distinguish *M. acantholepsis* from *M.devaneyi.*

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THREE NEW INDO-PACIFIC DAMSELFISHES OF THE GENUS *CHROMIS* (POMACENTRIDAE)

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Abstract

Randall, J.E., 1988. Three new Indo-Pacific damselfishes of the genus *Chromis* (Pomacentridae). *Memoirs of the Museum of Victoria* 49: 73-81.

The following new species of pomacentrid fishes of the genus *Chromis* are described: *C. alpha, C. caudalis* and *C. delta*. All are deep-reef species of the western Pacific, including Australian waters. They were designated as *Chromis* A, C and D respectively by G. R. Allen (1975) in his *Damselfishes of the South Seas*. *C. alpha* is distinct in having 3 spiniform caudal rays, usually XIII,12 dorsal rays, 16-18 pectoral rays, and a moderately deep body (depth 1.8-2.0 in SL); in life there are usually one or more small yellowish spots on the scales of the body, especially anterodorsally, the lower part of the body is blue, and the anal fin largely deep blue. *Chromis caudalis* and *C. delta* are both dark brown with pale caudal peduncle and fin, a large black spot at the pectoral base, 2 spiniform caudal rays, and usually XII,13 dorsal rays. *Chromis caudalis* usually has 17 pectoral rays (usually 16 for *delta*), usually 14 lateral-line scales (usually 13 for *delta*), a deeper body (1.65-1.85 in SL, compared to 1.8-2.1 for *delta*), and longer caudal and pectoral fins; the dark spot on the pectoral base is hemispherical in *caudalis* and round in *delta*; the pectoral axil of adults of *caudalis* is bright blue in life.

Introduction

The author has made a long-term study of the Indo-Pacific species of the damselfish genus *Chromis* which has resulted in the following papers to date: Randall and Swerdloff (1973) reviewed the eight Hawaiian species of the genus; Allen and Randall (1980) reviewed the Red Sea species of the family Pomacentridae which included seven species of *Chromis*; Randall, Ida and Moyer (1981) recognised 20 species of the genus from Japan and Taiwan. Randall and Allen (1982) described *C. pelloura* from the Red Sea; and Randall and McCarthy (1988) named a new species from the Persian Gulf and Gulf of Oman.

The purpose of the present paper is to provide descriptions of three common species of *Chromis* which are typically found in deep-reef habitats in the western Pacific. One of the species extends its range eastward to the Society Islands. All three occur in Australian waters. These species were designated as *Chromis* spp. A, C and D by Allen (1975).

Lengths given for type specimens are standard length (SL) taken from the front of the snout to the base of the caudal fin. Proportional measurements are rounded to the nearest 0.05. Meristic and proportional data appearing in parentheses refer to paratypes if different from the holotype. Body depth is the maximum depth to the extreme base of the dorsal spines; measurements of fin spines are also taken to the base of these elements. Interorbital width is the least fleshy width and orbit diameter the maximum fleshy diameter. Caudal concavity is the horizontal distance between the tips of the longest and shortest caudal rays. Lateral-line scale counts were made only of those scales in the dorsoanterior series with tubes; pored scales which may be found posteriorly in the series were not counted. Gill-raker counts include all rudiments; the raker at the angle is contained in the lower-limb count. Tables 1 and 2 summarise the meristic data for all three species. For a diagnosis of the genus *Chromis* see Randall, Ida and Moyer (1981).

Type specimens have been deposited at the following institutions: Academy of Natural Sciences of Philadelphia (ANSP); Australian Museum, Sydney (AMS); Bernice Pauahi Bishop Museum, Honolulu (BPBM); Muséum National d'Histoire Naturelle, Paris (MNHN); U.S. National Museum of Natural History, Washington, D.C. (USNM), and Western Australian Museum, Perth (WAM).

Table 1. Counts of Fin Rays of Species of *Chromis*

	Dorsal Rays					Anal Soft Rays				Pectoral Rays			
	XII	XIII	12	13	14	11	12	13	14	15	16	17	18
C. alpha	1	45	44	2		1	43	2			1	20	25
C. caudalis	25		4	20	1		2	23			3	20	2
C. delta	42		3	38	1		4	37	1	3	38	1	

Table 2. Counts of Tubed Lateral-line Scales and Gill rakers of Species of *Chromis*

	Lateral-line Scales					Gill Rakers							
	12	13	14	15	16	24	25	26	27	28	29	30	31
C. alpha			5	29	12				10	19	11	5	1
C. caudalis		1	17	7				1	13	4	4	2	1
C. delta	5	35	2			1	[illegible]	17	13	4			

Chromis alpha sp. nov.

Figure 1

Chromis sp. "A" Allen, 1975: 94, middle fig. of p. 96.
Chromis sp. 1 Allen and Steene, 1979: 42.
Chromis sp. "A" Wass, 1984: 19.
Chromis sp. Randall and Randall, 1987.

Material examined. Holotype: Society Islands, Tetiaroa, off W side of Rimatuu Islet, outside reef in 45 m, 60° slope with rich coral bottom, spear, J.E. Randall, 24 Apr 1973, BPBM 14993, female (84.0 mm).

Paratypes: Society Islands, Tahiti, outside reef off Papeete Harbor, 25-40 m, spear, J.E. Randall, 29 Mar 1971, BPBM 11544, (2: 78.8-88.0 mm).

American Samoa, Tutuila, Fagatele Bay, E side, 39 m, spear, J.E. Randall, 27 Apr 1973, BPBM 14999 (77.5 mm); Fagatele Bay, edge of reef in 30-38 m, rotenone, J.E. Randall, R.C. Wass and G. Yamasaki, 8 May 1974, BPBM 17506 (76.6 mm).

Tonga Islands, Vava'u, SW side off Mo'ungalafa Mt., at latitude 18°29′30″S, 37 m, rotenone and spear, J.E. Randall and K. Okamoto, 18 Mar 1983, BPBM 30951 (2: 80.5-84.0 mm).

Fiji, Viti Levu, entrance to Suva Harbour, 30 m rotenone, B.A. Carlson, 10 Jul 1974, WAM P25283-001 (82.0 mm); NW tip of Great Astrolabe Reef, S of Usborne Pass (18°42′S, 178°29′E), ocean side of reef to 40 m, rotenone, V.G. Springer et al., 14 May 1982, BPBM 31159 (2: 78.0-86.3 mm).

Vanuatu, Éfaté, Undine Bay, G.R. Allen and W.A. Starck II, 24 Jun 1973, AMS I.17474-003 (78.0 mm); Espiritu Santo, Tutuba Island (15°45′S, 166°50′E), 45 m, explosives, G.R. Allen, 27 Jun 1973, WAM P24939 (5: 75.0-85.0 mm).

Australia, Queensland, Great Barrier Reef, Escape Reef, Australian Museum party, 28 Oct 1981, AMS I.22580-012 (80.5 mm); Lizard Island area, Australian Museum party, Nov 1975, AMS I.19476-021 (2: 75.0-76.0 mm).

Solomon Islands Guadalcanal, Doma Reef, 35 m, rotenone, J.E. Randall and G.R. Allen, 15 Jul 1973, BPBM 16083 (2: 50.8-76.9 mm).

Marshall Islands, Kwajalein Atoll, S end, 50 m SE of entrance to small boat passage, 70° drop-off with caves, 46 m, J.E. Randall, N.A. Bartlett, R. Hergenrother and K. Burnett, 8 Apr 1976, BPBM 19979 (71.0 mm); same data as preceding, MNHN 1976-129 (76.0 mm); Enewetak Atoll, Rigili (Leroy) Islet, W side of ocean reef, drop-off in 46 m, rotenone, J.E. Randall, G.W. Tribble, A.Y. Suzumoto and P. Lamberson, 5 Jul 1975, BPBM 18388 (77.0 mm).

Caroline Islands, Ponape (5°52′N, 158°6′E), SW side, ocean side of barrier reef to 36.5 m, rotenone, V.G. Springer et al., 15 Sep 1980, USNM 223922 (4: 72.8-82.5 mm).

Mariana Islands, Guam, Cocos Island, reef off NW side, steep drop-off, 29-37 m, rotenone, J.E. Randall, P. Helfrich, R. S. Jones and H. Kami, 28 May 1968, BPBM 6898 (4: 68.8-76.9 mm).

Palau Islands, Augulpelu Reef (SE of Koror), SW side at base of drop-off in 34-52 m, rotenone, J.E. Randall, A.R. Emery and E.S. Helfman, 22 Apr 1970, BPBM 30938 (14: 60.7-75.5 mm); Augulpelu Reef, quinaldine, W.A. Starck II, 4 Mar 1972, AMS I.16650-001 (46.2 mm).

Papua New Guinea, Madang, outer reef off middle of Kranket Island, 25-35 m, rotenone, G.R. Allen, 14 May 1972, BPBM 14702 (2: 57.3-59.8 mm); near Rapa Point (5°28′S, 155°37′E), steep drop-off near shore, 32-40 m, rotenone, G.R. Allen, 4 Oct 1983, WAM P28165-007

Figure 1. Holotype of *Chromis alpha*, BPBM 14993, 84.0 mm SL, Tetiaroa, Society Islands.

(75.0 mm); WAM P27826-025 (3: 71.0-75.0 mm); Admiralty Islands, Manus, S coast about 3 km from Momote Airfield (2°4'S, 147°25'E), vertical drop-off, 35-41 m, rotenone, G.R. Allen and R. Knight, 2 Sep 1986, WAM P27826-025 (3: 71.0-75.0 mm).

Philippines, Mactan Island (E of Cebu), off marine laboratory of University of San Carlos, vertical drop off in 30 m, spear, J.E. Randall, 25 Jun 1975, BPBM 18467 (3: 70.5-75.9 mm); Palawan, Puerto Princesa (9°44'N, 118°45'E), 12 m rotenone, R.E. Schroeder, 2 Jul 1979, USNM 273546 (76.0 mm).

Indonesia, Molucca Islands, Nusa Laut, N shore at Tandjung Tala, steep drop-off, 12-18.5 m, rotenone, V.G. Springer and M.F. Gomon, 16 Jan 1973, USNM 209903 (77.7 mm).

Cocos-Keeling Islands, Turk Reef, N side, drop-off in 36-49 m, spear, W.F. Smith-Vaniz, 20 Mar 1974, ANSP 134269 (82.2 mm).

Diagnosis. Dorsal rays XIII, 12 (one of 45 paratypes with XII spines and two with 13 rays); anal rays II,12 (rarely 11 or 13); pectoral rays 18 (16-18, rarely 16); spiniform caudal rays 3; tubed lateral-line scales 15 (14-16, usually 15); gill rakers 8 + 21 (7-9 + 19-23).

Body depth 1.85 (1.8-2.0) in SL; head length 3.2 (3.0-3.25) in SL; snout length 3.75 (3.5-4.05) in head; orbit diameter 2.8 (2.6-3.0) in head; interorbital width 2.6 (2.7-2.95) in head; caudal peduncle depth 2.0 (1.95-2.3) in head.

No auxiliary scales on body. Preopercular margin not serrate. Anterior nostril with narrow fleshy rim, slightly higher posteriorly; posterior nostril small elongate pore diagonally above and behind anterior nostril near orbit in front of upper margin of pupil. Pores of lateralis system on head small. Free margin of suborbital short, ending below a vertical at front edge of pupil.

Fifth to eighth dorsal spines longest, 1.55 (1.55-1.8) in head; interspinous membranes of dorsal fin moderately incised; margin of soft portion of dorsal fin somewhat pointed, fourth ray longest; base of soft portion of dorsal fin contained about 2.7 times in base of spinous portion; second anal spine 1.25 (1.2-1.35) in head; margin of soft portion of anal fin broadly rounded; caudal fin deeply forked, lobe tips acute but not filamentous, caudal concavity 3.75 (3.2-4.4) in SL; pectoral fins long, 2.5 (2.5-2.95) in SL; pelvic fins 3.05 (2.75-3.15) in SL.

Colour of holotype in alcohol. Brown, slightly darker dorsally than ventrally, centres of scales a lit-

tle paler than edges; narrow dark brown bar underlying posterior edge of preopercle and another along upper edge of gill opening; indistinct small black spot at upper base of pectoral fin; upper third to half of pectoral axil black; distal unscaled portion of spinous part of dorsal fin light brown; membranes of outer half of soft part of dorsal fin hyaline, rays brown; anal fin dark brown, only distal last few rays and associated membranes pale; caudal fin dark brown, rays and membranes shading to pale distally; paired fins pale, pelvics light brown laterally.

Colour of holotype when fresh. Scales of upper five-sixths of body and postorbital head with dark brown edges and greenish centres containing one or more yellowish blotches (the blotches yellow on head and anterodorsally on body); lower sixth of body purplish blue; narrow dark bar on opercular edge and gill opening above level of pectoral base; upper preopercular margin in a dark brown bar; median fins dark brown except posterior membranes which are clear and outer spinous portion of dorsal fin and outer anal fin which are orangish brown; paired fins slightly dusky, base of the pectorals dark brown, upper corner with still darker spot.

The following colour note was made from the four paratypes from Guam (BPBM 6898, 68.8-76.9 mm): dark greenish on back and sides, scales edged in blackish and centres with some dull yellow blotches; ventral part of head and body greyish blue; dorsal fin coloured like body; anal fin deep blue (blue-green anteriorly and basally); pectoral fins light grey with curved brown bar at base; pelvic fins greyish blue; upper edge of opercle and preopercle blackish. The blue ventral colour of the body faded soon after capture. There is considerable variation in the development of the yellow blotches in this species. On some individuals the spots are only faintly visible. Some fish show an intensification of the yellow spots on the caudal peduncle as well as anterodorsally on the body. Underwater the blue ventral part of the body is very evident; particularly striking is the deep blue of the anal fin and the even brighter blue of the outer unscaled part of the fin.

Etymology. Named *alpha* from the Greek *alphos*, white-spotted, as from leprosy, in reference to the pale spots on the head and body. Also the name was chosen because alpha is the first letter of the Greek alphabet. This fish was first diagnosed and illustrated by Gerald R. Allen (1975) who referred to it as *Chromis* sp. "A".

Distribution and habitat. This species occurs in the western Pacific from the Philippines through Indonesia and New Guinea to the Great Barrier Reef and eastward in Oceania to the Marshall Islands in the Northern Hemisphere and the Society Islands in the Southern. Its typical habitat is steep outer reef escarpments with small caves and ledges. It has been collected in 12 to 52 m, though is rarely encountered in less than 20 m. In some areas such as Mactan Island in the Philippines it is among the most common of the deep reef fishes.

Remarks. Chromis alpha is a moderately large species of the genus. Our largest specimen measures 88 mm SL, 124 mm total length. The above proportional measurements were based on ten specimens from 46.2 to 88 mm SL.

This damselfish is most closely related to an undescribed species of *Chromis* of which specimens have been taken in Kenya, the Maldive Islands, and the Seribu Islands off NW Java. The latter differs in having lower gill-raker counts (25-27) and in colour. It lacks the yellow flecks of *C. alpha* and has a large black area over most of the anal fin.

Chromis caudalis sp. nov.

Figure 2

Chromis sp. "C" Allen, 1975: 94, lower fig. on p. 97.
Chromis sp. 2 Allen and Steene, 1979: 43 (in part).

Material examined. Holotype: Solomon Islands, Alite Reef (off Malaita), outer reef slope, 46 m, spear, G.R. Allen, 24 Jul 1973, BPBM 15613, male (63.2 mm).

Paratypes: Caroline Islands, Ponape, Nankapenparam Reef (NE of Ponape Pass) (7°1'45'N, 158°13'55"E), ocean side of reef, 37-44 m, rotenone, V.G. Springer et al., 9 Sep 1980, USNM 223920 (2: 32.8-33.3 mm); same locality, 27.5-46 m, rotenone, V.G. Springer et al., 20 Sep 1980, USNM 223921 (4: 47.0-56.0 mm).

Palau Islands, Augulpelu Reef (SE of Koror), drop-off on SW side, 15.5-21 m quinaldine, J.E. Randall, 13 Apr 1970, BPBM 9376 (2: 42.4-46.0 mm); same locality, base of drop-off in 34-52 m, rotenone, J.E. Randall, A.R. Emery, and E.S. Helfman, 22 Apr 1970, BPBM 30948 (2: 55.7-56.9 mm); same locality, 46 m, rotenone, G.R. Allen, W.A. Starck II, R.C. Wass and G. Condit, 24 Jan 1972.

Solomon Islands, same data as holotype, BPBM 30950 (4: 55.6-64.8 mm); same locality, W end, steep outer reef slope, 34 m, spear, J.E. Randall, 26 Jul 1973, BPBM 15637 (56.5 mm).

Philippines, Siquijor Islands, about 2 km W of town of Siquijor (9°13.5'N, 123°29'E), 24.5-30.5 m, rotenone, L. W. Knapp et al., 14 May 1979, BPBM 31299 (2: 69.1-75.0 mm).

Indonesia, Molucca Islands, Ambon, NW coast of Ambon Bay about 1 km W of Sikula Point, 20 m, spear,

Figure 2. Holotype of *Chromis caudalis*, BPBM 15613, 63.2 mm SL, Alite Reef, Solomon Islands.

J.E. Randall and G.R.Allen, 18 Jan 1975, BPBM 19242 (2: 53.2-56.0 mm).

Christmas Island (Indian Ocean), off Ethel Beach (10°29′S, 105°40′E), 20-30 m, rotenone, G.R. Allen and R.C. Steene, 18 May 1978, WAM P26080-003 (75.4 mm); Flyingfish Cove, off cantilever, 25-35 m, rotenone, G.R. Allen and R.C. Steene, 27 May 1978, WAM P26099-012 (68.0 mm).

Diagnosis. Dorsal rays XII,13 (12-14, rarely 14); anal rays II,13 (12-13, rarely 12); pectoral rays 18 (16-18, usually 17); spiniform caudal rays 2; tubed lateral-line scales 14 (13-15, usually 14, rarely 13); gill rakers 9 + 20 (7-9 + 19-22).

Body depth 1.7 (1.65-1.85) in SL; head length 3.15 (3.0-3.25) in SL; snout length 3.7 (3.55-3.75) in head; orbit diameter 3.1 (2.6-3.2) in head; interorbital width 2.6 (2.5-2.85) in head; caudal peduncle depth 1.9 (1.8-2.0) in head.

No auxiliary scales on body. Posterior margin and corner of preopercle irregular, usually with a few poorly defined serrae. Anterior nostril with low fleshy rim, slightly higher posteriorly; posterior nostril a small opening diagonally above and behind anterior, near edge of orbit at level of upper edge of pupil. Some pores of lateralis system on head moderately large, especially those near nostrils and above orbit. Free edge of suborbital ending posterior to vertical at rear of pupil.

Last dorsal spine usually longest, 1.95 (1.55-1.9) in head; interspinous membranes of dorsal fin moderately incised; margin of soft portion of dorsal and anal fins acutely pointed, fifth dorsal ray and seventh or eighth anal rays longest; base of soft portion of dorsal fin contained about 2.1 times in base of spinous portion; second anal spine 1.5 (1.25-1.45) in head; caudal fin deeply forked, each lobe tip with 2 very long filamentous rays, caudal concavity 3.2 (1.6-3.2) in SL; pectoral fins moderately long, 2.85 (2.65-2.9) in SL; pelvic fins 2.9 (2.65-2.9) in SL.

Colour of holotype in alcohol. Dark brown, centres of scales paler than edges, particularly ventrally where they form faint pale stripes; caudal peduncle distinctly paler than rest of body, demarcation slightly posterior to rear base of dorsal and anal

fins; edge of orbit narrowly dark; lips slightly paler than rest of head; a narrow black band on side of snout passing anteriorly from middle of edge of orbit (band may be obscured by mucus); edge of opercle above level of pectoral base, posterior edge of preopercle, and ventral edge of suborbital narrowly darker brown than rest of head; large hemispherical black spot basally on pectoral fin, rounded part posterior, straight part coinciding with fin base; axil of pectoral fins black, black extending short distance on side of body dorsal to fin base; dorsal and anal fins dark brown except narrow region posterior to curve from rear base of each fin to attenuate tip which is abruptly hyaline with light brown rays; caudal fin slightly darker than peduncle, rays and membranes becoming pale distally; pectoral fins pale with light brown rays; pelvic fins dark brown.

Colour when fresh. The holotype dark brown, centres of scales on side of head and body yellowish, becoming yellow ventrally where they form stripes on thorax and abdomen; caudal peduncle bluish white, tinged with brown; dorsal and anal fins dark brown except posterior part of soft portion which is abruptly whitish with light brown rays; anterior margin of anal fin narrowly light blue to pointed tip; caudal fin light yellowish brown, shading to pale distally; pectoral fins hyaline with light brown rays and large black spot at base; pelvic fins dark brown, lateral edge narrowly light blue.

The colour illustration of *C. caudalis* in Allen (1975: lower figure of p. 97) shows a narrow light blue margin on the dorsal fin to the pointed tip of the soft portion of the fin and faint light blue edges basally on the caudal lobes; the inner rim of the iris is bright blue.

The axil of the pectoral fins of individuals of this species collected in the Palau Islands and Indonesia was observed to be bright deep blue. This striking colour feature is apparent on underwater photographs taken by the author in Indonesia in which the pectoral axil is visible.

Etymology. This species is named *caudalis* in reference to the very long caudal filaments; it has the highest caudal concavity of any species of *Chromis* (to 1.6 in the SL).

Distribution and habitat. This species is known from Indonesia, Philippines, Solomon Islands, Palau Islands, Caroline Islands and Christmas Island in the eastern Indian Ocean. The author collected two specimens (BPBM 19985, 52.0-61.3 mm) at the southern end of Kwajalein Atoll, Marshall Islands in 46-55 m which are here identified as *C. caudalis*; however they are not designated as paratypes. They did not exhibit the bright blue axil of the pectoral fins, nor did underwater photographs taken of this species at the same locality. It was also photographed underwater at Fanning Atoll in the Line Islands with the pectoral fin in a forward position; no blue is apparent in the pectoral axil. Specimens of *C. caudalis* have been collected in the depth range of 15.5-55 m. The species is typically found on steep outer reef slopes.

Remarks. The largest specimen of *Chromis caudalis* measures 75.4 mm SL and 115 mm in total length. The above proportional measurements were based on 11 specimens from 42.2 to 75.4 mm SL.

This species appears to be most closely related to *C. delta* which is described herein (see *Remarks* for *delta* for differentiation from *caudalis*) and to *C. alleni* Randall, Ida and Moyer from southern Japan. The latter differs in the orangish brown ground colour, a slightly deeper body, and more tubed lateral-line scales (15-17 for *alleni*, compared to 13-15, modally 14, for *caudalis*). Also *C. alleni* does not seem to reach as large a size as *caudalis*; the largest specimen of *alleni* measures 62.2 mm SL.

It is apparent from underwater photographs and observations that *C. caudalis* is variable in life colour. As noted above, Marshall Islands and Line Islands individuals lack the bright blue pectoral axil. It is not known if all fish in other parts of the range exhibit this colour feature or not. Some individuals are very dark brown, almost black, and the caudal peduncle, caudal fin, and posterior dorsal and anal fins more contrastingly white than the holotype and the fish photographed underwater by Allen (1975) in the Solomon Islands.

Chromis delta sp. nov.

Figure 3

Chromis sp. "D" Allen, 1975: 95, upper fig. of p. 100.
Chromis sp. Burgess and Axelrod, 1975: 1563, fig. 320.
Chromis sp. 2 Allen and Steene, 1979: 43 (in part).

Material examined. Holotype: Solomon Islands, Guadalcanal, 7 miles W of Honiara, reef adjacent to wreck of Japanese ship, 38-48 m, rotenone, J.E. Randall and G.R. Allen, 13 Jul 1973, BPBM 15584, female (36.6 mm).

Paratypes: Fiji, entrance to Nukulau Pass (18°11'S, 178°32'E), outer reef, 35 m, spear and quinaldine, G.R. Allen, 7 Jun 1973, AMS I.17506-004 (2: 22.4-41.9 mm); NW tip of Great Astrolabe Reef, S of Usborne Pass (18°42'S, 178°29'E), ocean side of reef to 40 m, rotenone,

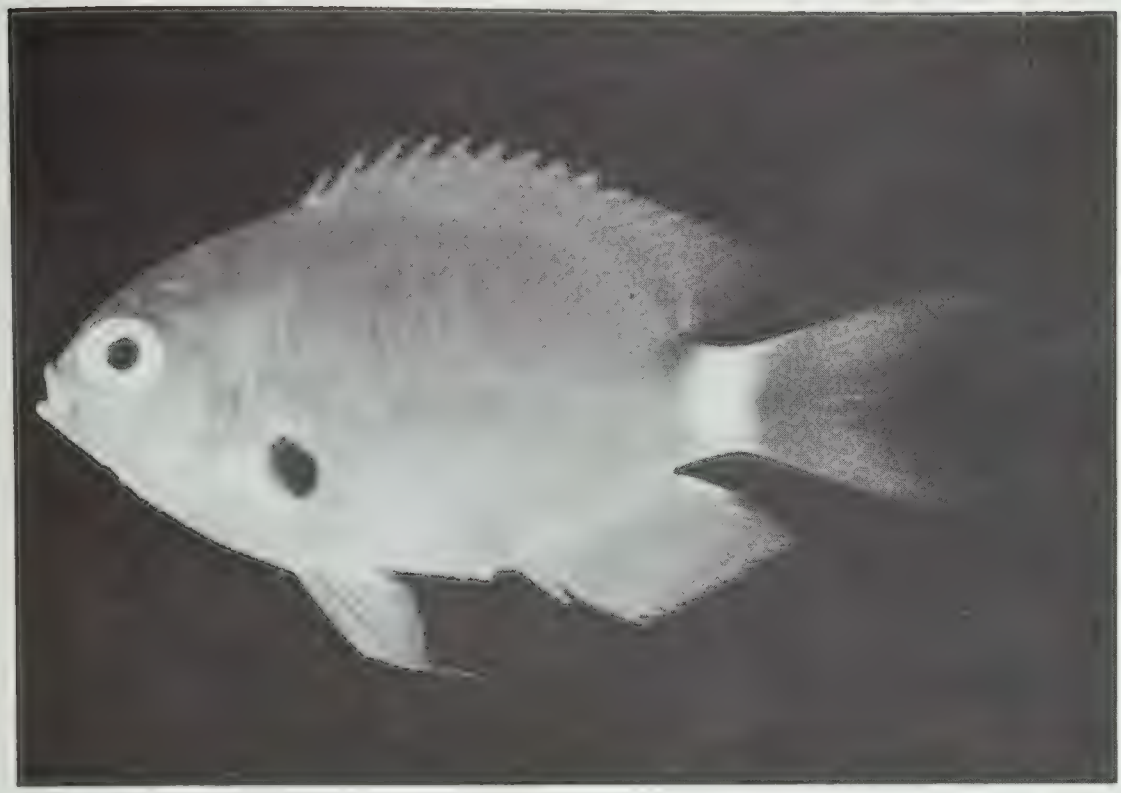

Figure 3. Holotype of *Chromis delta*, BPBM 15584, 36.6 mm SL, Guadalcanal, Solomon Islands.

V.G. Springer et al., 14 May 1982, BPBM 31158 (34: 13.9-48.7 mm).

Solomon Islands, same data as holotype, BPBM 30953 (3: 31.6-42.9 mm); Alite Reef (off Malaita), steep outer reef slope, 50 m, dynamite, J.E. Randall, W.A. Starck II, B. Goldman and W. Doak, 24 Jul 1973, BPBM 16188 (4: 31.7-39.4 mm).

Australia, Queensland, Great Barrier Reef, Lizard Island area, Australian Museum party, Nov 1975, AMS I.19476-020 (39.5 mm); Escape Reef (15°49′S, 145°50′E), reef and coral rubble, 52-60 m, rotenone, Australian Museum party, 4 Nov 1981, AMS I.22627-005 (2: 37.3-41.0 mm) same locality, Australian Museum party, 11 Nov 1981, AMS I.22632-008 (2: 44.0-45.5 mm).

Papua New Guinea, Madang, Kranket Island, outer reef slope, 30.5 m, rotenone, G.R. Allen, 10 Apr 1972, BPBM 14695 (9: 26.8-40.8 mm); Port Moresby, Bootless Inlet, Horseshoe Reef, ocean side, 37 m, P.L. Colin, 23 Jan 1984, BPBM 30252 (2: 18.2-28.7 mm).

Indonesia, Molucca Islands, Ambon, N side off Morilla, reef front with caves, 10-12 m, rotenone, J.E. Randall and G.R. Allen, 28 Jan 1975, BPBM 19358 (43.2 mm); Sulawesi (Celebes), Manado Bay, reef about 500 m from shore, 30 m, sodium cyanide, G.W. Tribble, 2 Sep 1978, BPBM 26678 (3: 17.0-49.3 mm); Banda Islands, Roen Island (4°32′36′S, 129°49′36″E), 9-15 m, rotenone, B.B. Collette, 8 Jul 1979, USNM 268413 (2: 18.5-38.7 mm); Bali, point just N of Padang Bai, base of reef front, 27 m, sodium cyanide and spear, J.E. Randall, 28 Feb 1984, BPBM 30187 (2: 24.3-33.5 mm).

Christmas Island (Indian Ocean), Flyingfish Cove, off cantilever, 25-35 m, rotenone, G.R. Allen and R.C. Steene, 27 May 1978, WAM P. 26099-026 (39.8 mm); Christmas Island, rotenone, G.R. Allen and R.C. Steene, 30 May 1978, AMS I.20441-008 (38.0 mm).

Palau Islands, Augulpelu Reef (SE of Koror), SW side, drop-off in 15.5-21 m, quinaldine, J.E. Randall, 13 Apr 1970, BPBM 30974 (2: 36.9-41.0 mm); same locality, 33.5-52 m, rotenone, J.E. Randall, A.R. Emery and E.S. Helfman, 22 Apr 1970, BPBM 9436 (11: 28.8-39.5 mm); Augulpelu Reef, S side, reef in 37-43 m, rotenone, J.E. Randall and R.L. Pyle, 15 Jul 1986, BPBM 31461 (23.8 mm).

Philippines, Mactan Island (E of Cebu), off marine laboratory of University of San Carlos, vertical drop off with caves and ledges, 28-35 m, spear and quinaldine, J.E. Randall, 26-27 Jun 1975, BPBM 18469 (2: 34.7-41.0 mm); Negros, off S end of Dumaguete City, isolated rock on rubble-soft coral bottom, 22 m, rotenone, J.E. Randall and K.E. Carpenter, 9 Aug 1978, BPBM 26512 (2: 19.1-26.3 mm); Luzon, Batangas, Caban Island, 45 m, rote-

none, J.E. Randall, G.W. Tribble and R. Lubbock, 13 Aug 1978, BPBM 26527 (40.4 mm).

Taiwan, S end, Nan Wan, middle of bay E of harbour at Hou-Pi-Hu, rocky pinnacle, 26 m, spear, J.E. Randall, 20 Jul 1978, BPBM 23435 (40.8 mm).

Diagnosis. Dorsal rays XII,13 (rarely 12 or 14); anal rays II,13 (rarely 12 or 14); pectoral rays 16 (rarely 15 or 17); spiniform caudal rays 2; tubed lateral-line scales 13 (12-14, rarely 14); gill rakers 7 + 19 (6-9 + 18-21).

Body depth 1.95 (1.8-2.1) in SL; head length 3.05 (2.95-3.2) in SL; snout length 4.0 (3.55-4.35) in head; orbit diameter 2.5 (2.3-2.8) in head; interorbital width 3.0 (2.7-3.0) in head; caudal peduncle depth 2.1 (1.95-2.15) in head.

No auxiliary scales on body. Posterior margin and corner of preopercle slightly irregular, sometimes with few poorly defined serrae. Nostrils as in preceding species except posterior nostril extremely small. Pores of lateralis system on head large. Free edge of suborbital ending posterior to a vertical at rear of pupil.

Fifth to twelfth dorsal spines subequal, 1.7 (1.6-1.8) in head; interspinous membranes of dorsal fin moderately incised; margin of soft portions of dorsal and anal fins acutely pointed, fifth or sixth dorsal rays and seventh or eighth anal rays longest; base of soft portion of dorsal fin contained about 2 times in base of spinous portion; second anal spine 1.35 (1.25-1.45) in head; caudal fin deeply forked, each lobe tip with 2 long filamentous rays, caudal concavity 3.0 (3.2-4.35) in SL; pectoral fins not long, 3.0 (2.9-3.35) in head; pelvic fins 2.6 (2.4-3.0) in head.

Colour of holotype in alcohol. Brown, scale edges darker than centres, anterior caudal peduncle with narrow dark brown bar which continues vertically into basal part of dorsal fin where it is darker than on body; rest of caudal peduncle abruptly pale; large subspherical black spot centred on pectoral-fin base, axil of fin also black; dorsal and anal fins brown except region posterior to curved line from base to pointed tips of these fins which is abruptly pale; caudal fin dusky brown basally, grading to pale distally; pectoral fins pale except basal dark spot; pelvic fins brown laterally, inner 2 rays and associated membranes pale.

Colour of holotype when fresh. Not very different from that in preservative. Ventral part of the body bluish grey, this coloration palest anterior to black pectoral-base spot and along lower edge of gill opening; lips bluish grey; suborbital suffused with iridescent light blue; small light blue spot on snout beneath anterior nostril; broad white bar over all but anterior caudal peduncle; iris bluish, inner rim lighter.

Underwater photographs of this species were taken by the author in Sulawesi and Luzon. The fish were dark grey, the scale edges even darker (due to the dark ground colour, the dark bar anteriorly on the caudal peduncle is only barely noticeable); caudal peduncle posterior to dark bar abruptly white; suborbital scales largely iridescent blue; upper lip partially blue; a short blue streak beneath anterior nostril; iris blue, the inner rim lighter blue; short, curved, posterior part of dorsal and anal fins clear with dusky rays; outer margin of dorsal and anal fins narrowly blue; caudal and pectoral fins clear with dusky rays; pelvic fins dark olive grey with a blue lateral margin.

Specimens from Fiji have a distinct blackish bar anteriorly on the caudal peduncle which extends into the anal fin as as well as the dorsal; this colour form was well illustrated by Allen (1975: upper figure of p. 100).

Etymology. Named *delta* from the fourth letter of the Greek alphabet in order to be linked with the previous designation of this fish, *Chromis* sp. "D" by Allen (1975).

Distribution and habitat. This species occurs in the western Pacific from Taiwan through the Philippines to Indonesia, New Guinea, Solomon Islands, and northern Great Barrier Reef. It extends eastward in Oceania only to the Palau Islands and Fiji. It has also been collected at Christmas Island in the eastern Indian Ocean. The typical habitat is steep outer reef slopes with good cover. Type specimens have been collected in the depth range of 10-60 m, but the species is not common in less than 20 m. Allen (1975: 95) recorded it to 80 m and noted that it is the most common pomacentrid fish in the Palau Islands at depths of 60-70 m. It is abundant on drop-offs in the Philippines and Indonesia as well.

Remarks. *Chromis delta* is a small species, the largest of the type specimens measuring only 49.3 mm SL and 73 mm in total length. Mature females as small as 32 mm SL are present in the type series.

Chromis delta is closely related to *C. caudalis*. Although Allen (1975: 94-95) distinguished the two as species C and D, respectively, Allen and Steene (1979) decided that D is the juvenile and C the adult of the same species. The two, however, are valid species. There is clear though overlapping meristic separation, as shown in Tables 1 and 2, for pectoral rays, tubed lateral-line scales, and gill rakers. In addition, *C. caudalis* has a deeper body on the

average, longer caudal filaments (when fully intact), and longer pectoral fins. Measurements of pectoral-fin lengths were made on 19 adult specimens of *caudalis* and 30 of *delta*. The SL/pectoral fin ratio for *caudalis* ranged from 2.63-2.89 whereas that for *delta* 2.90-3.39. The colour of the two species is very similar, but there is a difference in the shape of the large dark spot at the pectoral base; it is hemispherical in *caudalis*, the straight portion lying on the pectoral base, and essentially round in *delta*, with about half of the spot lying anterior to the fin base. Also *delta* lacks the dark line on the side of the snout, the faint striping ventrally on the body, and the bright blue pectoral axil in life.

Chromis delta is also very closely related to an undescribed species of the genus of which the author has specimens only from the Maldive Islands. The colour is almost identical to that of *delta*. The Maldives fish differs in having modally 12 dorsal soft rays, 23-27 gill rakers, and less pointed soft portions of the dorsal and anal fins.

Acknowledgements

Support for this study was provided by grants from the National Science Foundation (No. GB-8732) and the Charles Engelhard Foundation; these grants are gratefully acknowledged. Thanks are also due the individuals who collected the specimens of *Chromis* reported herein and the ichthyological staffs of the following institutions for the loan of specimens: Australian Museum, U.S. National Museum of Natural History, and the Western Australian Museum. The manuscript was reviewed by Gerald R. Allen and Helen A. Randall.

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A NEW SPIDER OF THE GONDWANAN GENUS *EILICA* FROM VICTORIA, AUSTRALIA (ARANEAE: GNAPHOSIDAE)

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Abstract

Platnick, N.I., 1988. A new spider of the Gondwanan genus *Eilica* from Victoria, Australia (Araneae: Gnaphosidae). *Memoirs of the Museum of Victoria* 49: 83-84.

Eilica mullaroo, new species, is the first laroniine gnaphosid from Victoria.

Introduction

The widespread, Gondwanan spider genus *Eilica* is currently known from America (10 species found from the southern United States to Chile), Africa (two species found from Sierra Leone to the Cape Province), and southern Asia (three species found in India and Uzbekistan) as well as Australia. The six Australian species documented in previous studies (Platnick, 1975, 1978, 1985) have been recorded from Queensland, New South Wales, South Australia, and Western Australia. It was therefore with great interest that I examined a collection of an *Eilica* species from Victoria kindly made available by Dr Mark S. Harvey of the Department of Environmental Records of the Museum of Victoria. Not surprisingly, the species proved to be undescribed.

The spiders were collected through a pitfall-trapping program carried out in the arid and semi-arid regions of the north-western part of the state (with financial aid from the Land Conservation Council of Victoria). These habitats are worthy of much further study, not least to determine if the *Eilica* there have myrmecophilous habits similar to those of other members of the subfamily (Noonan, 1982).

The format of the description follows that of Platnick (1975); all measurements are in millimetres.

Gnaphosidae

Eilica mullaroo sp. nov.

Figures 1-4

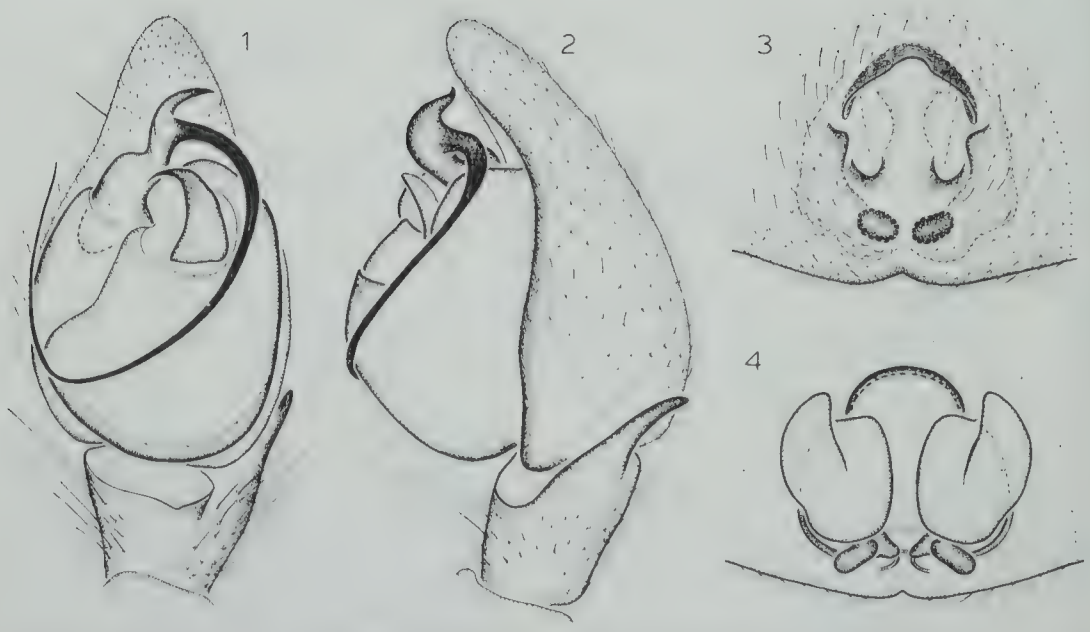
Types: Holotype male: Victoria, 15.8 km NE of Patchewollock (35°17'S, 142°19'E), drift fence pitfall trap at site 51, A. L. Yen, Oct 1985, Museum of Victoria, K712.

Paratype female: same data as holotype, Museum of Victoria, K713.

Other material examined. (Except as noted, all specimens were collected by A.L. Yen in drift fence pitfall traps during Nov 1985, and are deposited in the Museum of Victoria.) Victoria: 8.8 km N of Cullulleraine (34°12'S, 141°35'E), 2 males 1 female; 4.6 km E of Hattah (34°46'S, 142°19'E), Oct 1985, 2 males; 5.4 km E of Hattah (34°47'S, 142°20'E), Oct 1985, 2 males; 15 km SSE of Hattah (34°54'S, 142°15'E), Oct 1985, 2 males; 17 km SW of Hattah (34°51'S, 142°08'E), Oct 1985, 3 males; 7.7 km ENE of confluence of Lindsay River and Mullaroo Creek (34°07'S, 141°12'E), 1 female; 8.3 km SE of confluence of Lindsay River and Mullaroo Creek (34°11'S, 141°10'E), 1 male; 2 km N of Millewa Sth Bore (34°45'S, 141°04'E), 1 female; 3.1 km N of Millewa Sth Bore (34°45'S, 141°04'E), 1 male; 3.7 km N of Millewa Sth Bore (34°45'S, 141°04'E), 1 male; 17.8 km N of Millewa Sth Bore (34°37'S, 141°04'E), 1 male, 1 female; 19.4 km N of Millewa Sth Bore (34°36'S, 141°03'E), 1 male; 6.5 km SW of junction of Murray Valley Highway and Annuello Road (34°50'S, 142°34'E), Oct 1985, 2 males; 7.8 km SW of junction of Murray Valley Highway and Annuello Road (34°50'S, 142°33'E), Oct 1985, 3 males, 2 females (1 male, 1 female deposited in American Museum of Natural History); 8.1 km S of junction of Murray Valley Highway and Annuello Road (34°52'S, 142°37'E), Oct 1985, 1 male; 23.7 km SE of Murrayville (35°25'S, 141°23'E), 1 male, 2 females.

Diagnosis. Males resemble those of *E. contacta* Platnick (from Queensland and New South Wales) in having a relatively long embolar base bearing a semicircular distal projection, but differ in lacking a similar proximal projection and in having a much larger median apophysis (figs. 1, 2); females can easily be recognized by the arched anterior epigynal margin and paired paramedian openings (figs. 3, 4).

Description. Male: Total length 5.99. Carapace 2.35 long, 1.87 wide. Femur 11 1.94 long. Cara-



Figures 1-4. *Eilica mullaroo*, new species. 1. Left palp, ventral view. 2. Left palp, retrolateral view. 3. Epigynum, ventral view. 4. Epigynum, dorsal view.

pace brown with dark reticulations; abdominal dorsum gray with pair of longitudinal, paramedian anterior white stripes (as in Platnick, 1975, fig. 4) and posterior median white spot (as in Platnick, 1978, fig. 1); legs orange with distal tips of femora darkened. Cheliceral retromargin with three laminae set in strip of unsclerotized cuticle, two most distal ones large, most proximal one small, shifted prolaterally, sharply pointed; chelicerae medially excavate, lined anteromedially by series of short spines, similar spines lining distal margin of endites. Eye sizes and interdistances: AME 0.12, ALE 0.14, PME 0.16, PLE 0.12; AME-AME 0.12, AME-ALE 0.05, PME-PME 0.07, PME-PLE 0.09, ALE-PLE 0.12; MOQ length 0.41, front width 0.36, back width 0.39. Embolar base protuberant, distally twisted, with semicicular distal projection (fig. 1); retrolateral tibial apophysis narrow (fig. 2). Leg spination: tibiae: I p1-0-1, v2-2-2; II p0-0-1; III p1-1-1; IV d1-0-1, p1-1-1, v2-2-2; metatarsi: III p0-1-1, r0-1-1; IV p0-1-1, v2-2-2, r1-1-1.

Female: Total length 7.76. Carapace 3.49 long, 2.72 wide. Femur II 2.42 long. Coloration and chelicerae as in male. Eye sizes and interdistances: AME 0.14, ALE 0.14, PME 0.16, PLE 0.13; AME-AME 0.16, AME-ALE 0.05, PME-PME 0.15, PME-PLE 0.14, ALE-PLE 0.24; MOQ length 0.54, front width 0.44, back width 0.47. Anterior epigynal margin arched (fig. 3), posterolateral epigynal ducts narrow (fig. 4). Leg spination: femur IV p0-0-1; tibiae: I p1-0-1, v2-2-2; II p1-0-1; III d1-0-1, p1-1-1; IV d1-0-1, p1-1-1, v2-2-2; metatarsi: III p1-1-2, r1-1-1; IV p1-1-1, v2-2-2, r1-1-1.

Etymology. The specific name is a noun in apposition taken from Mullaroo Creek where the species has been collected.

Distribution. Known only from north-western Victoria.

Acknowledgements

I thank Dr Mark Harvey and Ms Catriona McPhee of the Museum of Victoria for access to these fascinating spiders, and Dr M. U. Shadab of the American Museum of Natural History for assistance with illustrations.

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MORE AUSTRALIAN SPECIES OF *HALIOPHASMA* (CRUSTACEA: ISOPODA: ANTHURIDAE)

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Abstract

Poore, G.C.B. and Lew Ton, H.M., 1988. More Australian species of *Haliophasma* (Crustacea: Isopoda: Anthuridae). *Memoirs of the Museum of Victoria* 49: 85-106.

Six new species of *Haliophasma* Haswell (*H. beaufortia* and *H. dillwynia* from north-western Australia; *H. darwinia* from north Queensland; *H. swainsonia* and *H. templetonia* from south-eastern Australia; and *H. blandfordia* from all these areas) are described and figured. New distributional records of eight other south-eastern Australian species are added. A key to all known species of *Haliophasma* from Australia is presented and the generic composition discussed.

Introduction

This paper follows an earlier contribution on species of *Haliophasma* from south-eastern Australia (Poore, 1975). It is based on additional material from the same region and from tropical Australia. Material upon which the work is based has come from the collections of Australian museums and the Commonwealth Scientific and Industrial Research Organization (CSIRO), Division of Fisheries North-west Shelf Survey.

Material is lodged in the Museum of Victoria, Melbourne (NMV), Australian Museum, Sydney (AM), Queensland Museum, Brisbane (QM), Tasmanian Museum, Hobart (TM), South Australian Museum, Adelaide (SAM) and Western Australian Museum, Perth (WAM). Poore and Lew Ton (1986) explained the abbreviations used in figures. Species names are derived from the Australian flora and follow a pattern established by Poore (1984) for *Paranthura*. Scale marks are 1.0 mm and refer to the whole animal only.

Haliophasma Haswell, 1881

Haliophasma Haswell, 1881: 476.—Barnard, 1925: 131; 1940: 382.—Menzies and Barnard, 1959: 17.—Poore, 1975: 504.—Kensley, 1982: 116.—Negoescu and Wägele, 1984: 118, 135, 136.

Exanthura Barnard, 1914: 336a. Type species *Exanthura macrura* Barnard, 1914. Synonymised by Kensley, 1982: 116.

Nemanthura Wägele, 1981: 114. Type species *Haliophasma valeriae* Paul and Menzies, 1971. New synonymy.

Silophasma Schultz, 1977: 840. Type species *Haliophasma geminatum* Menzies and Barnard, 1959. Synonymised by Negoescu and Wägele, 1984.

Type species. Haliophasma purpureum Haswell, 1881.

Remarks. Poore's (1975) generic diagnosis is generally adequate and requires only a few additions.

The flagellum of antenna 2 is of 3 articles (the small basal article was overlooked by Poore). The mandibles are asymmetrical, the left molar having a small tooth which is absent in the right molar (see fig. 1). Pereopod 1 article 6 has a submarginal row of setae along the palm and also a mesial row. On pereopods 2 and 3 article 6 is barely more swollen than on succeeding legs and bears a stout seta on its posterodistal margin. Pereopods 4-7 have a stout seta on the posterodistal margins of articles 5 and 6.

Negoescu and Wägele (1984: 135) referred to *Haliophasma* as a "collecting pot". To some extent this is true and attempts to divide it into smaller genera have not been successful. Poore (1975) recognised three groups of species from south-eastern Australia separated on the basis of the rostrum, pereopod 1, mandible, maxilliped and shape of head. Attempts to place species from other regions in these groups have not been successful. Exclusion of *H. geminatum* on the basis of absence of dorsal grooves and pits is not warranted and *Silophasma* Schultz is thereby synonymised.

Negoescu and Wägele (1984) regarded both *Exanthura* Barnard and *Nemanthura* Wägele as valid genera. *Exanthura* was differentiated from *Haliophasma* on the basis of two autapomorphies—pleonites fused dorsally only and hook-like projections on the peduncle of antenna 1. With the discovery of *Haliophasma beaufortia* sp. nov. which has hook-like projections on an-

Key to Australian species of *Haliophasma*

1. Rostrum prominent, about one-fifth length of head; dactylus of pereopod 1 strongly curved, article 6 cylindrical ..... *H. falcatum*
— Rostrum small; dactylus of pereopod 1 curvilinear, palm blade-like, article 6 flattened 2
2. Head wider than long; rostrum broad, rounded-truncate; pereon and pleon strongly pitted or sculptured dorsally and laterally 3
— Head as long as or longer than wide; rostrum acute to subacute; pereon and pleon weakly or not pitted laterally and dorsally 5
3. Pereopod 1 propodal palm strongly oblique ..... *H. pugnatum*
— Pereopod 1 Propodal palm on axis of limb 4
4. Pereon with 2 pairs of low carinae dorsally, separated by deep pitted grooves ..... *H. canale*
— Pereon with dorsolateral grooves and few pits dorsally ... *H. cribense*
5. Antenna 1 with hook extending over top of head ..... *H. beaufortia*
— Antenna 1 without hook 6
6. Exopod of uropod cleft ..... *H. purpureum*
— Exopod of uropod with sinuous dorsal margin, not cleft 7
7. Maxillipedal palp terminal article well exceeding first 8
— Maxillipedal palp terminal article level with or barely exceeding apex of first 10
8. Pereopod 1 propodal palm strongly produced, chelate .... *H. darwinia*
— Pereopod 1 propodal palm axial, subchelate 9
9. Telson more or less paralel-sided, apex acute ..... *H. dillwynia*
— Telson sharply tapered or waisted at mid-point, apex bluntly rounded *H. blandfordia*
10. Telson not sculptured or ridged dorsally, a simple dome 11
— Telson with crest, ridges or pits dorsally 13
11. Pereopod 1 propodal palm with proximal blunt tooth .... *H. cycneum*
— Pereopod 1 propodal palm straight 12
12. Dorsally pigmented; head wider than long ..... *H. swainsonia*
— Not pigmented; head longer than wide ..... *H. yarra*
13. Telson with a high, narrow dorsal crest ..... *H. pinnatum*
— Telson without a crest 14
14. Telson strongly tapering to acute upturned apex ..... *H. elongatum*
— Telson with rounded or broadly angled apex 15
15. Uropodal exopod twice as long as wide; telson apex broadly triangular *H. templetonia*
— Uropodal exopod 3 times as long as wide; telson apex rounded *H. syrtis*

tenna 1, but otherwise can be regarded as a good species of *Haliophasma*, this character cannot be considered generically significant. The dorsally fused pleonites cannot, on their own, be used to differentiate the genus. In *Malacanthura*, a related genus, the pleon may have dorsally complete grooves (e.g. *M. schotteae* Kensley), grooves absent dorsally (e.g. *M. transkei* Kensley) or no grooves at all (e.g. *M. pseudocarinata* (Barnard)).

Nemanthura was differentiated from *Haliophasma* on the basis of its slender body, elongate form of pereopod 1 and (again) the hook on the peduncle of antenna 1 (Negoescu and Wägele, 1984). A similarly slender body is found in *Haliophasma darwinia* sp. nov., which is otherwise a species of *Haliophasma*. On its own the morphology of pereopod 1 is not sufficent to warrant the maintenance of *Nemanthura* and the genus is placed in synonymy with *Haliophasma*.

Other characters explored by us have not been more useful in dividing the genus. For example, there is a tendency for the terminal article of the maxilliped to be larger in tropical species than tem-

perate ones but this is not correlated with other characters.

In male adults the flagellum of antenna 1 is of two forms. In some species (e.g. *Haliophasma cribense* Poore) the flagellum is of about 15 discoidal articles and reaches a little beyond the posterior margin of the head (see fig. 6). In other species the flagellum is of 16-20 isometric articles and reaches beyond the posterior margin of pereonite 1 (see figs. 5, 7, 13 and 15).

The identification of isolated males is extremely difficult. Elongation of the body and limbs obscures many of the characters useful in species recognition, e.g. shape of head, telson and pereopod 1.

Haliophasma beaufortia sp. nov.

Figures 1, 2

Material examined. 9 juveniles; 5.4-11.7 mm.

Holotype: WA, North-west Shelf, between Port Hedland and Dampier (18°41.6′S, 118°39.4′E), mud-sand-shell, 134 m, epibenthic sled, G.C.B. Poore and H.M. Lew Ton on FRV "Soela", 4 Jun 1983 (stn NWA-21), NMV J12426 (with 1 slide), juvenile, 6.0 mm.

Paratypes: WA, North-west Shelf, between Port Hedland and Dampier: 19°05′S, 117°26′E, 120 m, muddy sand (stn NWA-52), NMV J12447(1); 19°37′S, 118°53′E, 31 m, coarse shell (stn NWA-14), J12452(1); 19°49′S, 117°52′E, 52 m, epibenthic sled, T. Ward on FRV "Soela" (CSIRO stn B13), J12453(1), J12469(2); 19°59′S, 117°51′E, 42 m (CSIRO stn B1), J12470(1), J12471(1); 19°05′S, 118°54′E, 83 m (CSIRO stn B4), J12472(1); 19°28′S, 118°55′E, 38 m (CSIRO stn B9), J12718(1).

Description. Head and pereon with scattered small pits. Head about 1.4 times as long as wide, tapering anteriorly; anterolateral lobesnot swollen; rostrum as long as anterolateral lobes, apex acute. Pereonite 1 with pair of small rounded bosses on posterior margin. Pereonites 4-6 with distinct elongate pits anteriorly. Pereonite 7 slightly longer than wide, anteriorly with round depression. Pleon longer than wide, little longer than pereonite 7. Pleonites 1-5 with broad, poorly defined mid-dorsal and lateral keels, double row of small pits running length of mid-dorsal keel; lateral keels with several transverse rows of smaller pits. Telson 3.3 times as long as wide, 1.8 times as long as pleon; waisted close to base, broadening,lateral margins largely parallel, apex broadly rounded; dorsally with narrow, well-defined keel.

Mandibular palp exceeding incisor by half its length, article 3 with 9 setae. Maxillipedal palp article 2 clearly exceeding first. Antenna 1, article 1 of peduncle produced posterolaterally to form hook-like projection. Pereopod 1 subchelate, propodal palm axial, crenellate, setal rows sparse. Uropodal endopod not reaching apex of telson, little more than twice as long as broad, about as long as peduncle; broadest over proximal one-third, tapering to acute apex. Uropodal exopod reaching beyond peduncle, convex medially, lateral margin sinuous and crenellate, 2.6 times as long as wide.

Distribution. Western Australia, North-west Shelf, 31-134 m.

Remarks. The hook-like projections on the peduncle of antenna 1 are unique among Australian *Haliophasma.* However, two species from South Africa, *Haliophasma austroafricanum* Kensley and *H. macrurum* (Barnard), also share this character. *H. beaufortia* is readily distinguished from these. *Haliophasma austroafricanum* has a broader uropodal exopod and *H. macrurum* an exceptionally wide telson.

Haliophasma blandfordia sp. nov.

Figures 3-5

Material examined. 2 males, 25 juveniles; 7.4-21.9 mm.

Holotype: WA, North-west Shelf, between Port Hedland and Dampier (19°04′S, 119°00′E), 82 m, epibenthic sled, T. Ward on FRV "Soela", 1 Sep 1983 (CSIRO stn B11), NMV J12478, juvenile, 21.9 mm.

Paratypes: WA, North-west Shelf, between Port Hedland and Dampier (same collector): 19°29′S, 118°52′E, 36 m (CSIRO stn B8), NMV J12479(1); 19°30′S, 118°52′E, 37 m (CSIRO stn D2), J12480(1); 19°59′S, 118°51′E, 42 m (CSIRO stn B1), J12481(1); 19°29′S, 118°52′E, 37 m (CSIRO stn D1), J12482(1).

Other material: WA, North-west Shelf, between Port Hedland and Dampier (same collector): CSIRO stn B6, NMV J12483 (1 male); CSIRO stn B7, J12484 (1 male); (G.C.B. Poore and H.M. Lew Ton) stn NWA-14, J12594(1); stn NWA-12, J12595(1); stn NWA-21, J12597(1).

Qld, off Townsville, 26-45 m, muddy sand, dredge, G.C.B. Poore and H.M. Lew Ton, 24 Nov 1982: stn AIMS-3, NMV J12593(1); stn AIMS-7, J12596(3). Lizard Island, coral rubble, 6 m, P.C. Terrill, 7 Sep 1978, NMV J12598(1).

Eastern Bass Strait: stn BSS-32, NMV J8416(2); stn BSS-33, J8418(1); stn BSS-35, J8417(1); stn BSS-162, J8414(1); stn BSS-167, J12474(1, with 1 slide), J8412(4); stn BSS-168, NMV J8413(1) (See Wilson and Poore, 1987, for station details.)

Description. Head and pereon with scattered pits. Head as long as wide, tapering anteriorly, anterolateral lobes swollen distally. Rostrum as long as anterolateral lobes, acute. Pereonite 1 distolateral margin tuberculate, posterior margin with pair of angular bosses. Pereonites 4-6 with distinct elongate pits anteriorly. Pereonite 7 as long as wide,

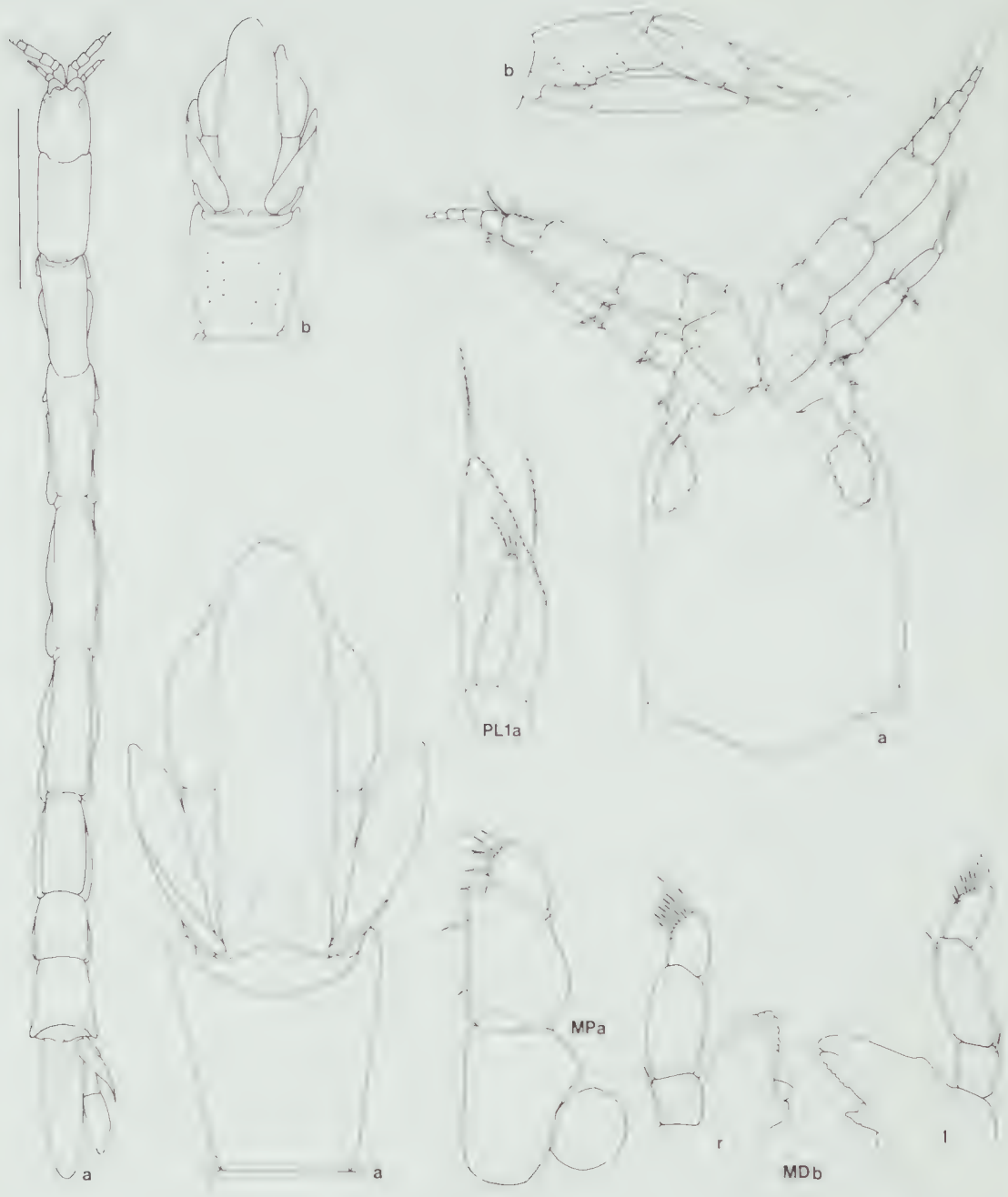

Figure 1. *Haliophasma beaufortia*. a, holotype juvenile, 6.0 mm; b, paratype juvenile, 11.7 mm, NMV J12453.

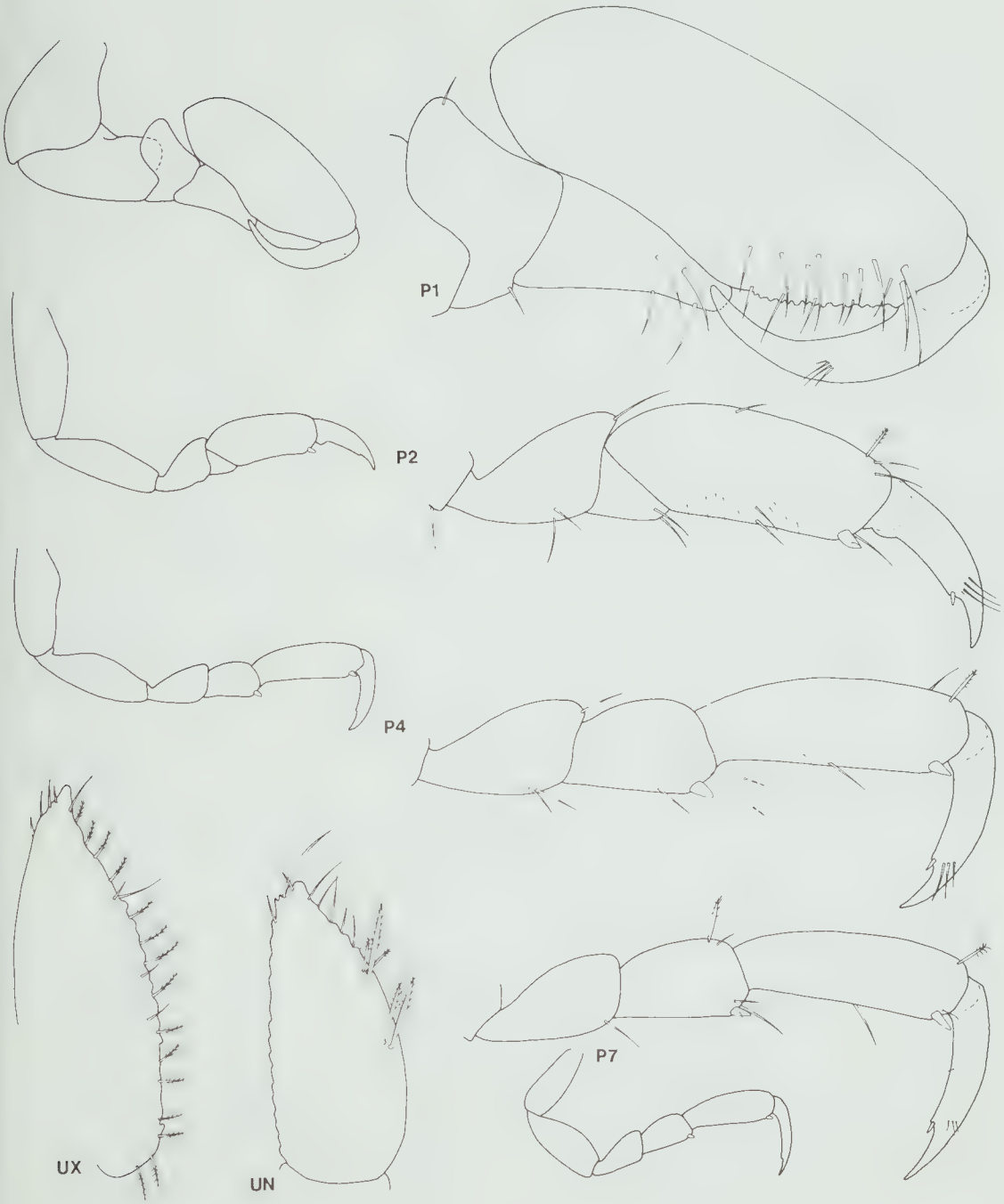

Figure 2. *Haliophasma beaufortia.* Holotype juvenile, 6.0 mm.

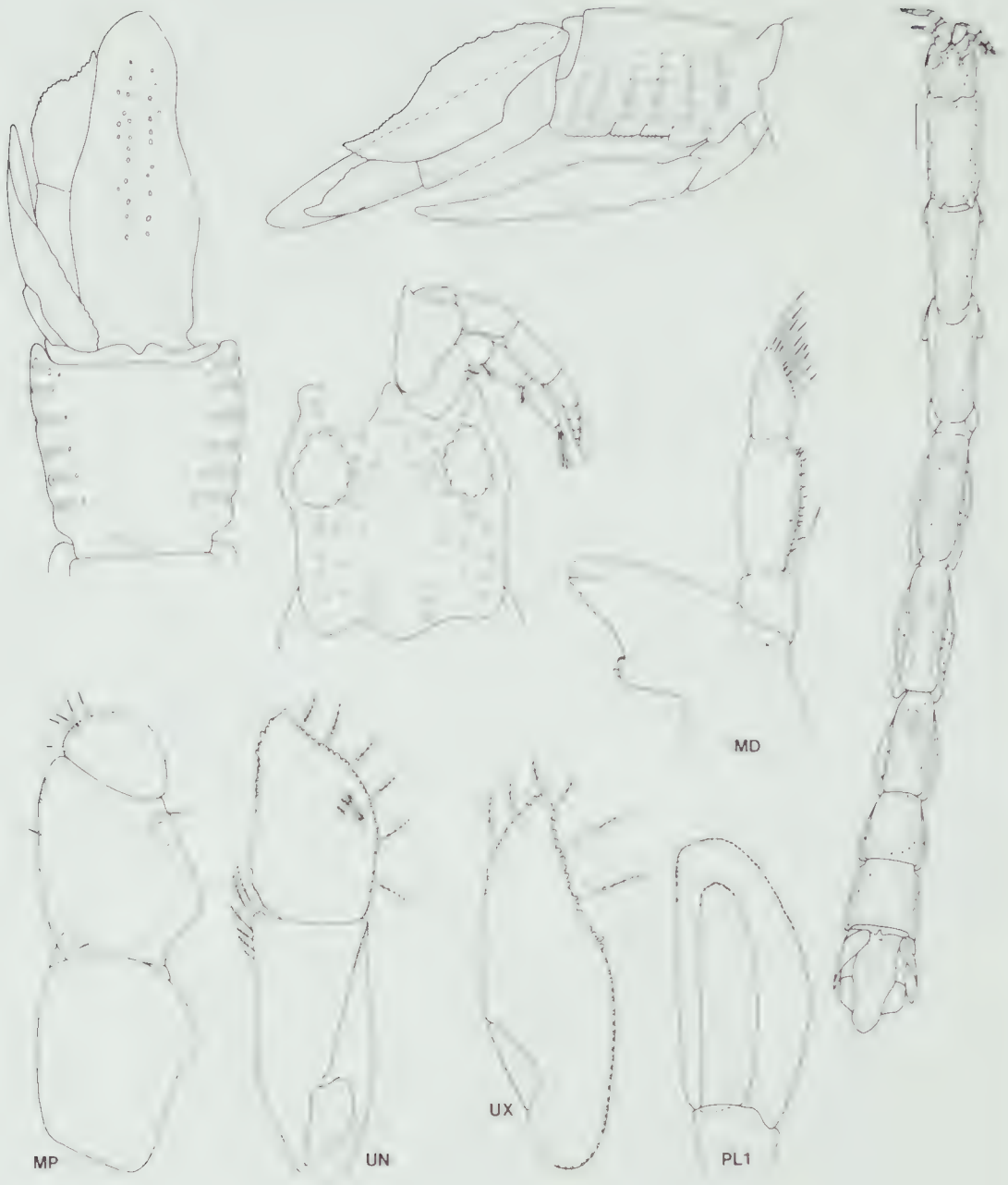

Figure 3. *Haliophasma blandfordia.* Holotype juvenile, 21.9 mm.

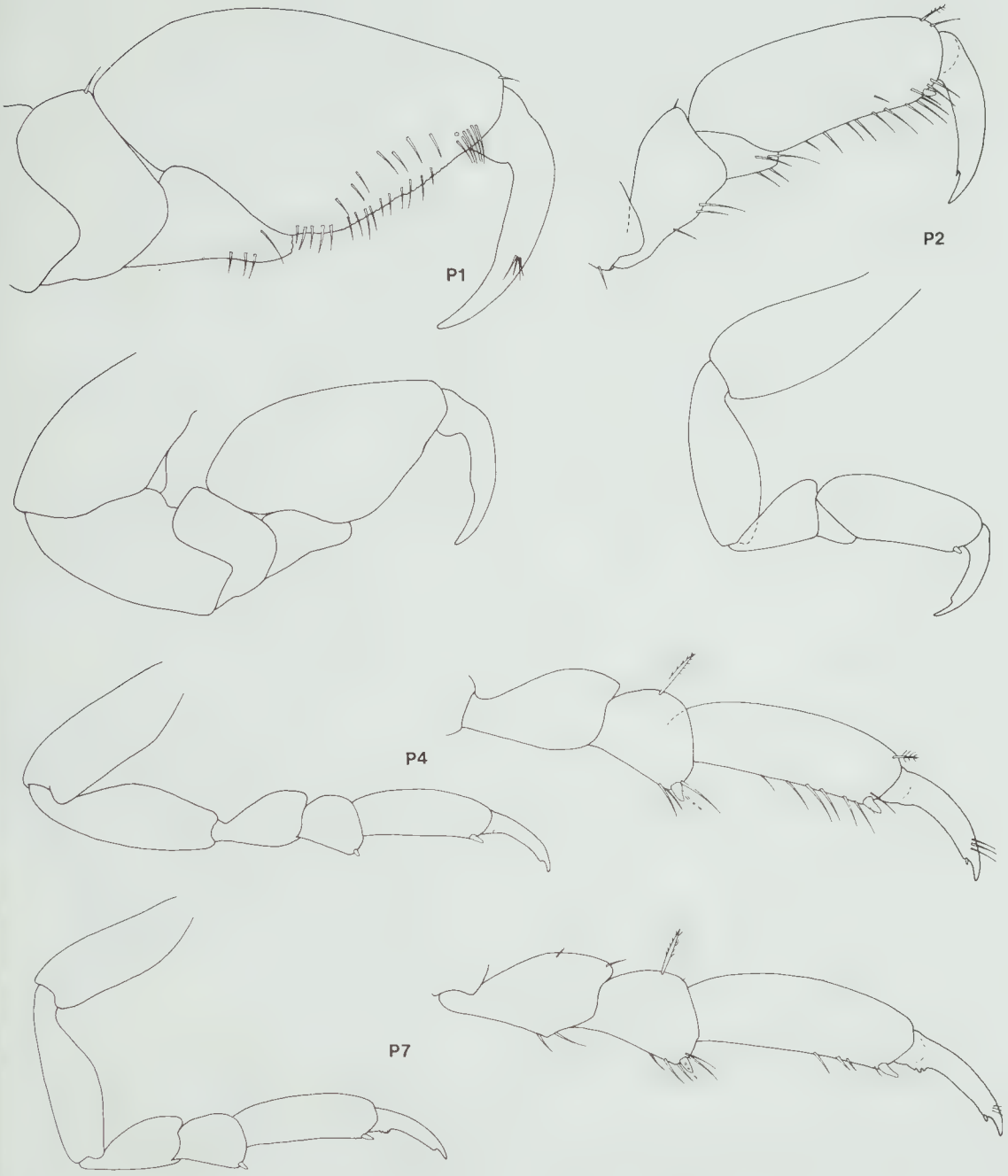

Figure 4. *Haliophasma blandfordia.* Holotype juvenile, 21.9 mm.

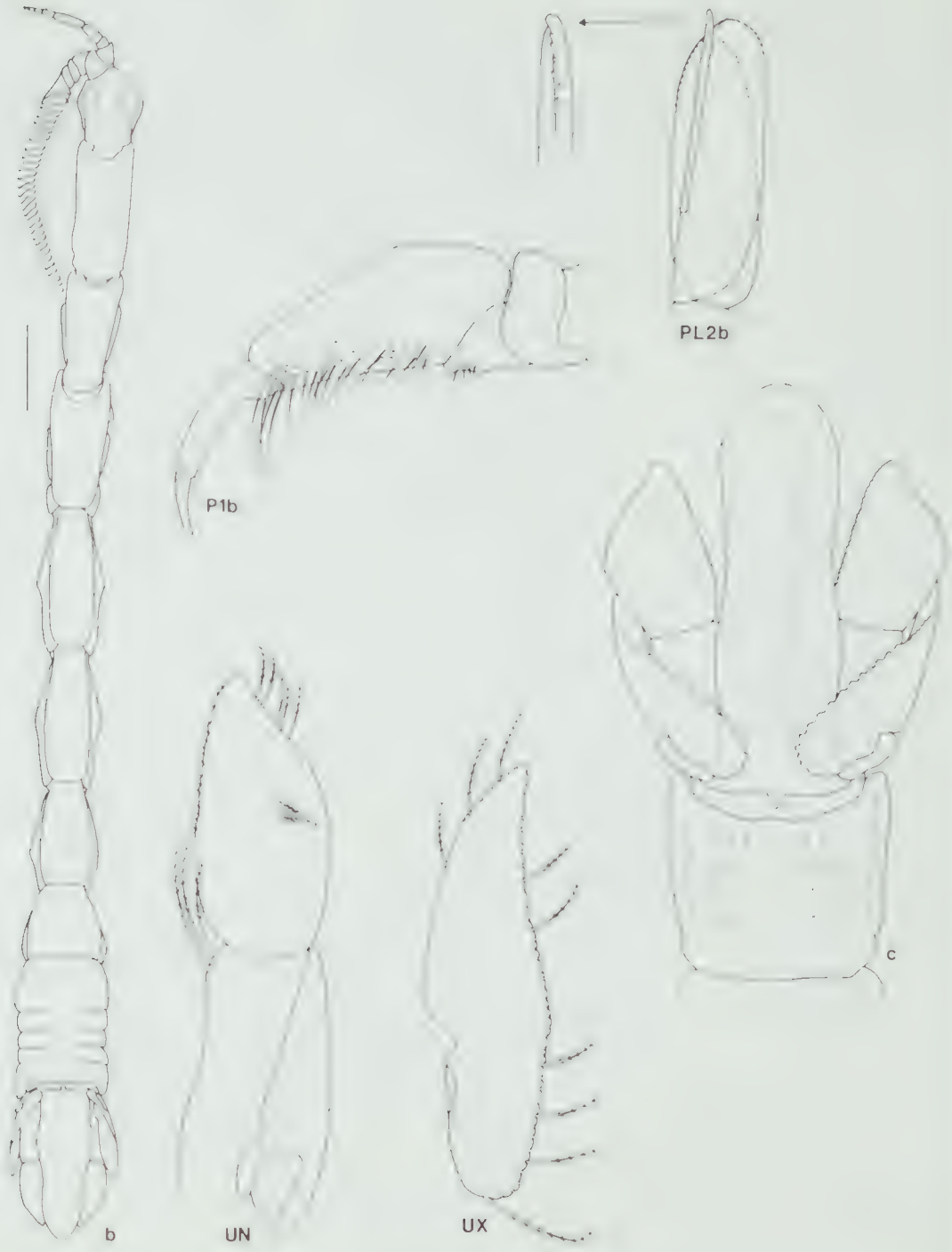

Figure 5. *Haliophasma blandfordia*. b, male, 14.3 mm, NMV J12483. c, juvenile, Bass Strait, 8.8 mm, NMV J12474.

with large round depression near anterior margin. Pleon about as long as wide, about as long as pereonite 7. Pleonites 1-5 without dorsal keel, anteriorly with large complex pit; laterally with transverse row of pits. Telson 2.5 times as long as wide, 1.6 times as long as pleon; widest at midpoint, tapering abruptly to give shouldered effect, apex rounded; with well developed dorsal keel.

Mandibular palp exceeding incisor by half its length, article 3 with a comb of 10 setae. Maxillipedal palp article 2 clearly exceeding first. Antenna 1, peduncle article 1 not modified. Pereopod 1 subchelate, propodal palm oblique, smooth, with 2 setal rows. Uropodal endopod not reaching apex of telson, 1.6 times as long as wide, about as long as peduncle, broadest over proximal half, tapering to acute apex. Uropodal exopod reaching beyond peduncle; convex medially, lateral margin sinuous and crenellate; 3 times as long as wide.

Male. Pereon little modified. Pleon more swollen than in juvenile. Antenna 1 of about 30 aesthetasc-bearing articles, reaching to pereonite 2. Pereopod 1 propodal palm setose. Uropodal rami and telson more elongate than in juvenile. Pleopod 2 appendix masculina as long as endopod, apex with setules.

Distribution. Western Australia, North-west Shelf, 31-122 m; Queensland, 6-45 m; Bass Strait, 51-329 m.

Remarks. Haliophasma blandfordia is readily distinguished by the combination of the shape of the telson and the palm of pereopod 1.

The two male specimens were assigned to this species on the basis of the shape of the telson although they differ in size and head shape.

The specimens from Bass Strait were somewhat smaller (maximum 9.0 mm) than those from tropical Australia (maximum 21.9 mm). The telson is broader apically but otherwise they cannot be easily distinguished from larger tropical specimens.

Haliophasma canale Poore

Haliophasma canale Poore, 1975: 505-507, figs. 1, 2.—Wägele, 1981: 83.—Negoescu and Wägele, 1984: 119.

Material examined. Qld, Middle Banks, Moreton Bay, S. Cook, Dec 1973 (QUBS stn), QM collection.

NSW, off South Head (33°52′S, 151°23′E), 44 m, 11 Dec 1980 (NSW State Fisheries stn K80-20-11), AM P32652(3), AM P32655(1). Off Nowra (34°59.52′S, 151°05.94′E), 204 m, G.C.B. Poore et al. on RV "Franklin", 14 Jul 1986, NMV J14467(1).

Bass Strait, 55-329 m: stn BSS-32, NMV J8386(1); stn BSS-33, J8385(1); stn BSS-154, J8561(1); stn BSS-158, J8382(1); stn BSS-165, J8381(1); stn BSS-167, J8384(1); stn BSS-202, J8383(1). (See Wilson and Poore, 1987, for details.)

Tas., N. of Northdown (41°11′S, 146°11′E), Wesley Vale Offshore Survey stn 25g, Tasmanian Sea Fisheries Division, 11 Jun 1971, TM G1715(1). Maria Island, 2 km E. of Cape Boullanger (42°34′S, 148°06′E), 50 m, R.S. Wilson on RV "Challenger", 23 Apr 1985, NMV J11978(1). Off Woodbridge (43°10′S, 147°17′E), 27 m, fine black mud and shell, 17 Apr 1985, R.S. Wilson on FV "Penghana", NMV J11980(2).

Remarks. New material of this species extends its distribution to Queensland, New South Wales, Tasmania and Bass Strait. *Haliophasma canale* is now known from bays and the shelf over a depth range of 3-329 m.

Haliophasma cribense Poore

Figure 6a

Haliophasma cribensis Poore, 1975: 508-510, figs. 3, 4.—Negoescu and Wägele, 1984: 119.

Material examined. NSW, off South Head (33°52′S, 151°23′E), 44 m, 11 Dec 1980 (NSW State Fisheries stn K80-20-11), AM P32654(5 specimens), P33606(1). Twofold Bay (37°05′S, 149°54′E), AM P36058(1).

Vic., Wilsons Promontory, Hobbs Head (39°02′S, 146°28′E), 10 m, R. Wilson and C. Jordan, NMV J11974(1).

Bass Strait, 55-101 m: stn BSS-79, NMV J8409(1); stn BSS-119, J8419(1); stn BSS-120, J8411(3); stn BSS-181, J8410(1); stn BSS-184, J8408(1). (See Wilson and Poore, 1987, for details.)

Tas., off Point Sorell (41°10′S, 146°34′E), Wesley Vale Offshore Survey stn 16, Tasmanian Sea Fisheries Division, 10 Jun 1973, TM G1716(1). Off Woodbridge (43°10′S, 147°17′E), 27 m, fine black mud and shell, 17 Apr 1985, R.S. Wilson on FV "Penghana", NMV J11973(1). Off Woodbridge (43°11′S, 147°15′E), 10 m, fine black mud, 17 Apr 1985, R.S. Wilson on FV "Penghana", NMV J11972 (1).

Remarks. Haliophasma cribense is typical of many southern species in that the male antenna 1 flagellum is only as long as the head (fig. 6a). New material of this species extends its distribution from Victoria to New South Wales and Tasmania in bays and on the shelf over a depth range of 7-101 m.

Haliophasma cycneum Poore

Figure 6b

Haliophasma cycneum Poore, 1975: 511-512, fig. 5.—Negoescu and Wägele, 1984: 119.

Material examined. Bass Strait, 82-124 m: stn BSS-167, NMV J11975(1 specimen with 1 slide); stn BSS-158, J8415(1), J8554(1). (See Wilson and Poore, 1987, for details.)

SA, Spencer Gulf, 10 m, SA Fisheries collection, SAM collection.

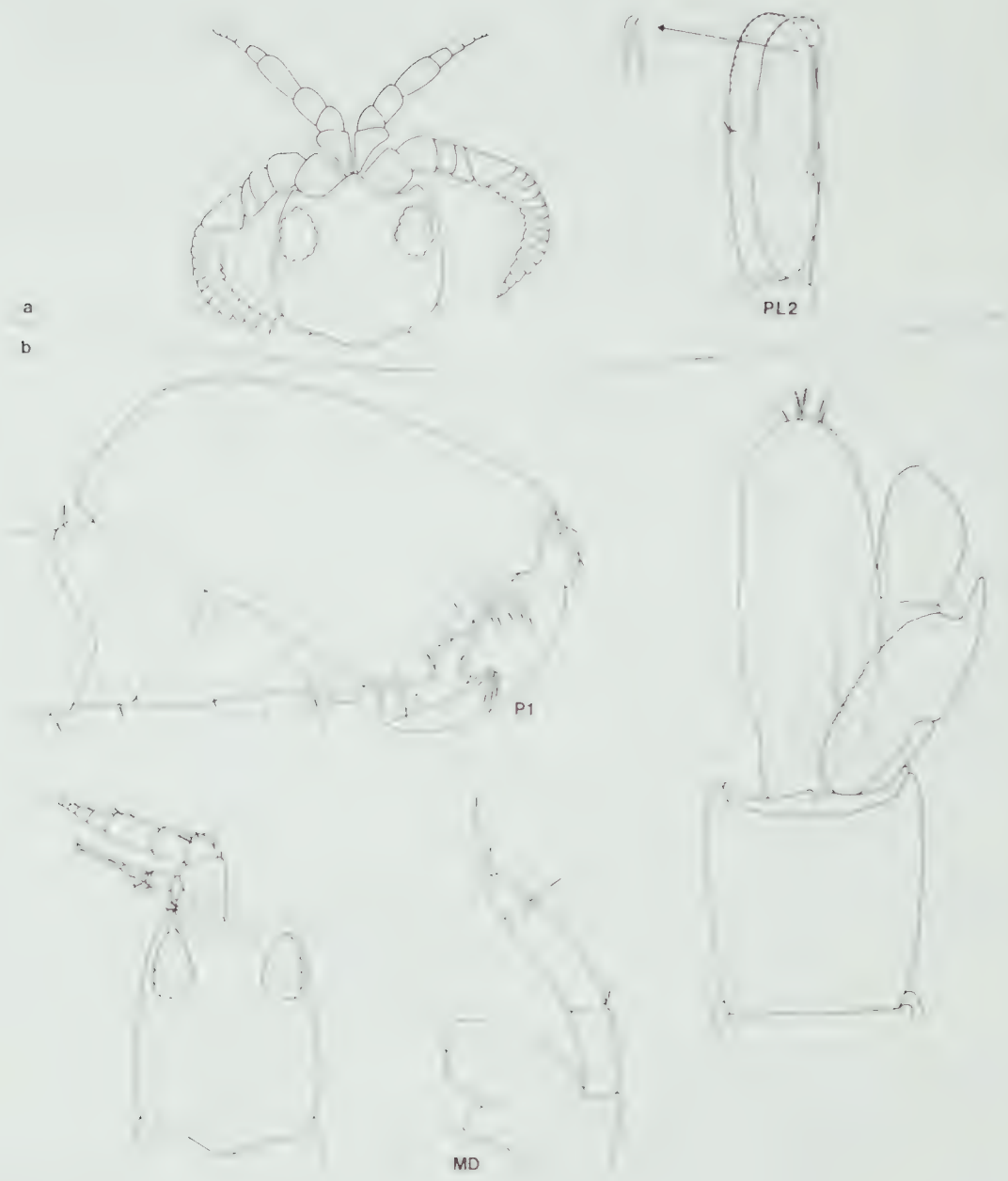

Figure 6. a. *Haliophasma cribense*. Male, 11.7 mm, NMV J8419. b, *Haliophasma cycneum*. Juvenile, 8.6 mm, NMV J11975.

Distribution. Bays in Victoria and South Australia (to 10 m) and Bass Strait, 82-124 m.

Remarks. Originally described from a specimen from a shallow bay within Port Phillip Bay, the new Bass Strait material considerably expands the bathymetric range of this species. There are minor differences between the Bass Strait material and the holotype (shape of head, telson, mandibular palp, palm of pereopod 1) but these are not considered to be of specific value.

A specimen from Bass Strait is figured to show these differences.

Haliophasma darwinia sp. nov.

Figures 7, 8

Material examined. 1 male, 3 juveniles; 8.0-12.8 mm.

Holotype: Qld, Bowling Green Bay (19° 18′S, 147°07′E), coarse silt, P. Arnold, 23 Oct 1974 (Three Bays Survey), NMV J12465(with 1 slide), juvenile, 10.1 mm.

Paratypes: Qld, NE. of Townsville (18°56′S, 146°50′E), muddy sand, 24 m, G.C.B. Poore and H.M. Lew Ton on RV "The Harry Messel", 24 Nov 1982, NMV J12466(1).

WA, North-west Shelf, between Port Hedland and Dampier, T. Ward on FRV "Soela", 19°30′S, 118°52′E, 36 m (CSIRO stn B8), NMV J12467(1); 19°30′S, 118°52′E, 37 m (CSIRO stn D1), J12468 (male).

Description. Head and pereon with sparse irregular pits dorsally, pereonites 1-7 with lateral row of pits. Head longer than wide, tapering; anterolateral lobes swollen distally only. Rostrum as long as anterolateral lobes, acute. Pereonite 1, posterior margin with pair of angular bosses. Pereonites 4-6 with elongate pits anteriorly. Pereonite 7 twice as long as wide, without anterior depression. Pleon 2.1 times as long as wide, longer than pereonite 7. Pleonites 1-5 without keels, with small scattered pits concentrated at lateral margins. Telson 3 times as long as wide, about as long as pleon; narrow at base, broad over middle one-third, tapering gently to rounded apex; with well-defined, narrow dorsal keel.

Mandibular palp exceeding incisor by half its length, article 3 with 2 terminal setae. Maxillipedal palp article 2 clearly exceeding first. Antenna 1, peduncle article 1 not modified. Pereopod 1 subchelate, propodal palm strongly produced, dactylus closed against this projection. Uropodal endopod reaching almost to apex of telson, about as long as peduncle, 2.4 times as long as broad, broadest over proximal one-third, tapering to acute apex. Uropodal exopod reaching beyond peduncle; convex medially, lateral margins sinuous and crenellate; 3 times as long as wide.

Male. More elongate than juvenile, pereopod 1 propodal palm with strong projection, telson with paired longitudinal carinae. Pleopod 2, appendix masculina not reaching apex of endopod, covered with setules; apex with smalllateral flange.

Distribution. North-eastern and north-western Australian shelf, 24-37 m.

Remarks. The extremely narrow body of *Haliophasma darwinia* and the strongly produced palm of pereopod 1 distinguish it from other Australian species. Other species which have a strongly produced palm are *H. tricarinatum* Barnard from South Africa and *H. cycneum* Poore from southern Australia. Neither is as narrow or has such a prominent palmar tooth as *H. darwinia.*

Haliophasma dillwynia sp. nov.

Figures 9, 10

Material examined. 1 juvenile, 5.9 mm; 1 post-manca, 5.0 mm.

Holotype: juvenile, 5.9 mm, NMV J12473 (with 1 slide). Western Australia, North-west Shelf, between Port Hedland and Dampier (18°41.6′S, 118°39.4′E), mud-sand-shell, 134 m, epibenthic sled, G.C.B. Poore and H.M. Lew Ton FRV "Soela", 4 Jun 1983 (stn NWA-21).

Paratype: WA, North-west Shelf, between Port Hedland and Dampier (19°05′S, 117°26′E), muddy sand, 122 m, epibenthic sled, G.C.B. Poore and H.M. Lew Ton on FRV "Soela", 12 Jun 1983 (stn NWA-52), NMV J12592 (post-manca).

Description. Head and pereon smooth. Head about as long as wide, anterolateral lobes broadly based Rostrum not as long as anterolateral lobes, apex acute. Pereonite 1 with pair of small rounded bosses on posterior margin. Pereonites 4-6 with distinct elongate pits anteriorly. Pleon about as long as wide, about as long as pereonite 7. Pleonites lacking keels and pits. Telson 3 times as long as broad and 1.7 times as long as pleon; sides parallel over most of length, tapering to angular apex; with dorsal keel.

Mandibular palp exceeding incisor by more than half its length, article 3 with 4 terminal setae. Maxillipedal palp article 2 clearly exceeding first. Antenna 1, peduncle article 1 not modified. Pereopod 1 subchelate, propodal palm linear, not crenellate; submarginal and mesial setae sparse. Uropodal endopod not reaching apex of telson, twice as long as broad and about as long as peduncle; broadest proximal to midpoint, tapering to acute apex. Uropodal exopod reaching beyond peduncle; convex medially, lateral margin sinuous and crenellate.

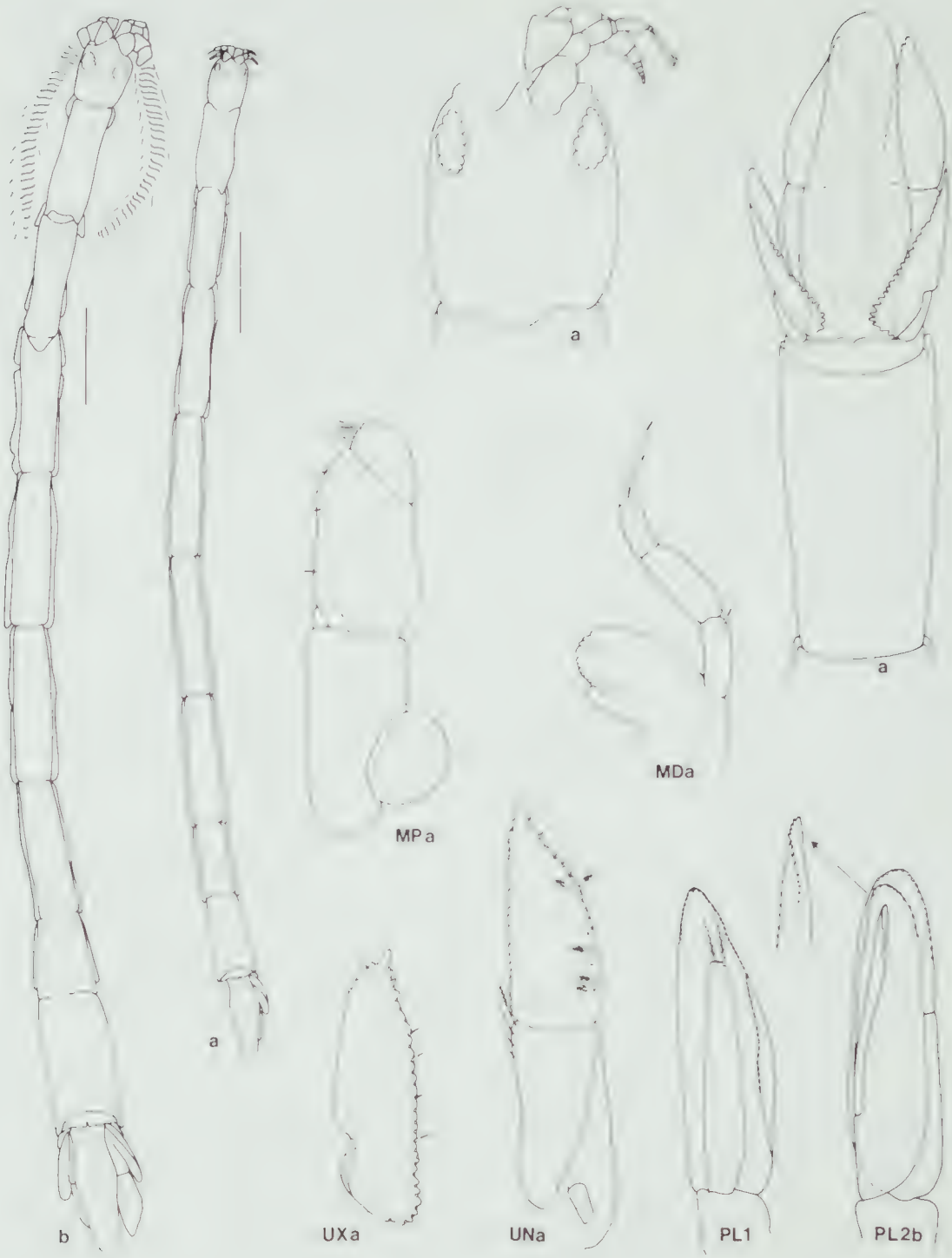

Figure 7. *Haliophasma darwinia.* a, holotype juvenile, 10.1 mm; b, paratype male, 12.8 mm, NMV J12468.

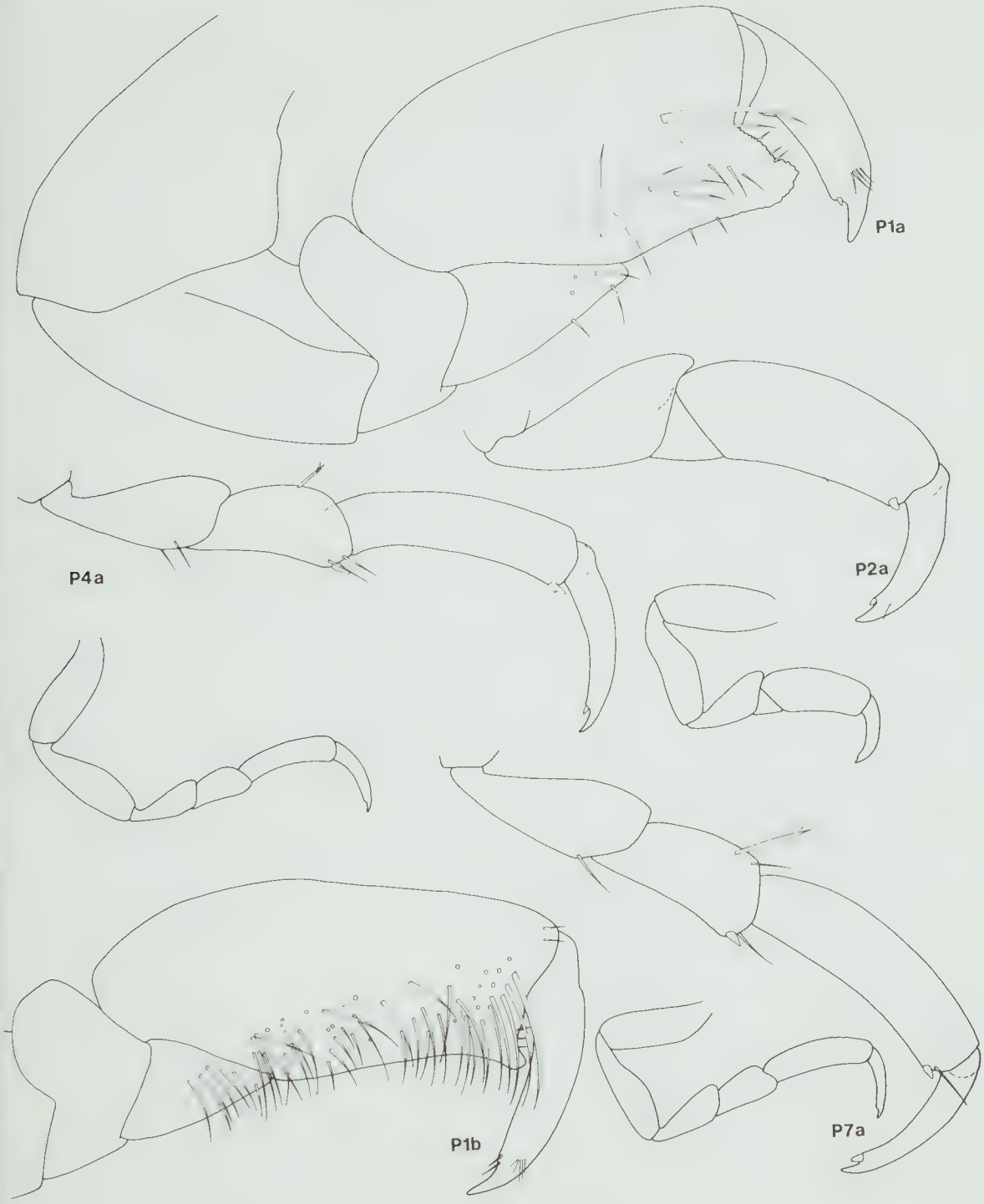

Figure 8. *Haliophasma darwinia.* a, holotype juvenile, 10.1 mm; b, paratype male, 12.8 mm, NMV J12468.

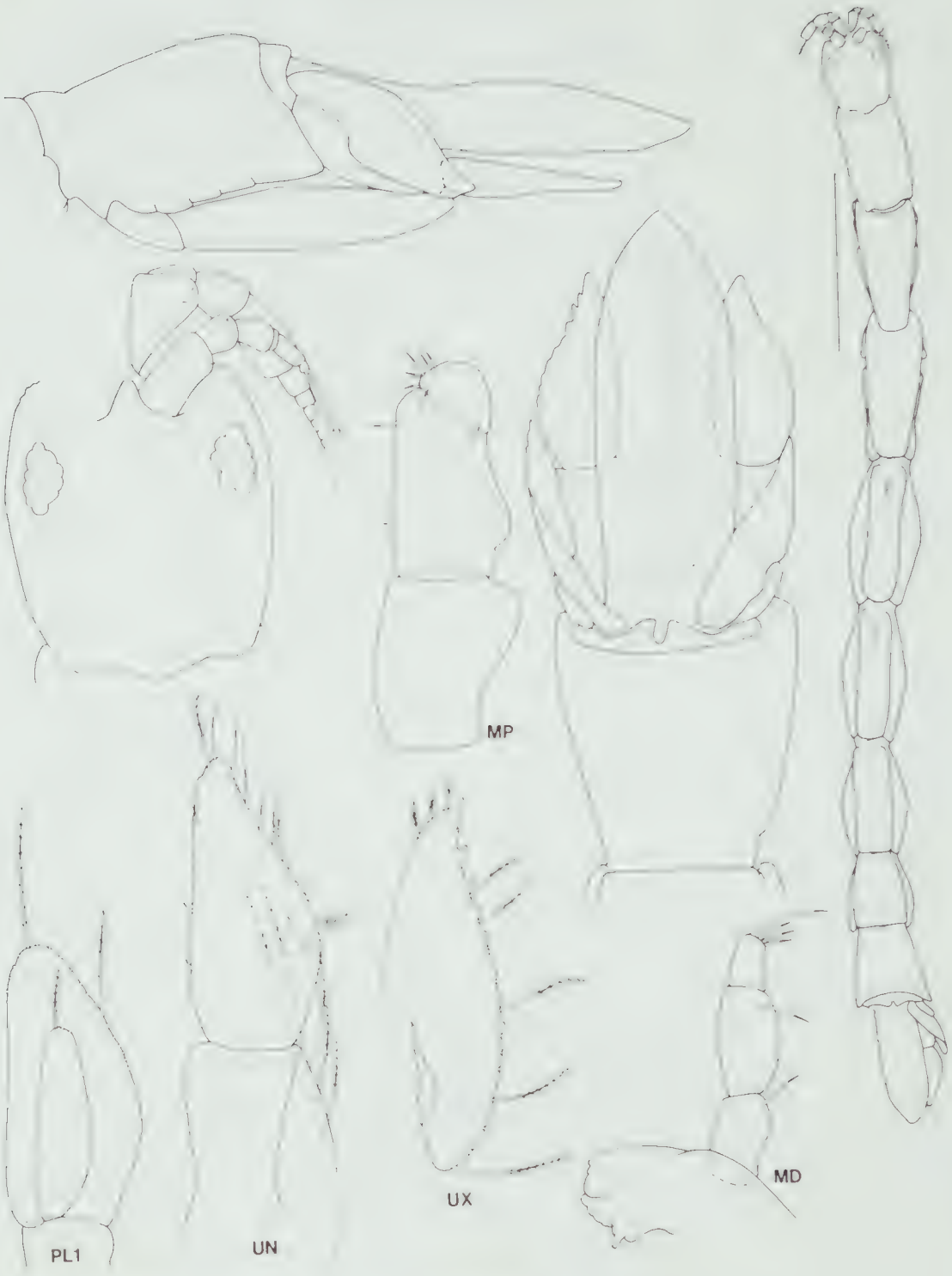

Figure 9. *Haliophasma dilwynia*. Holotype juvenile, 5.9 mm.

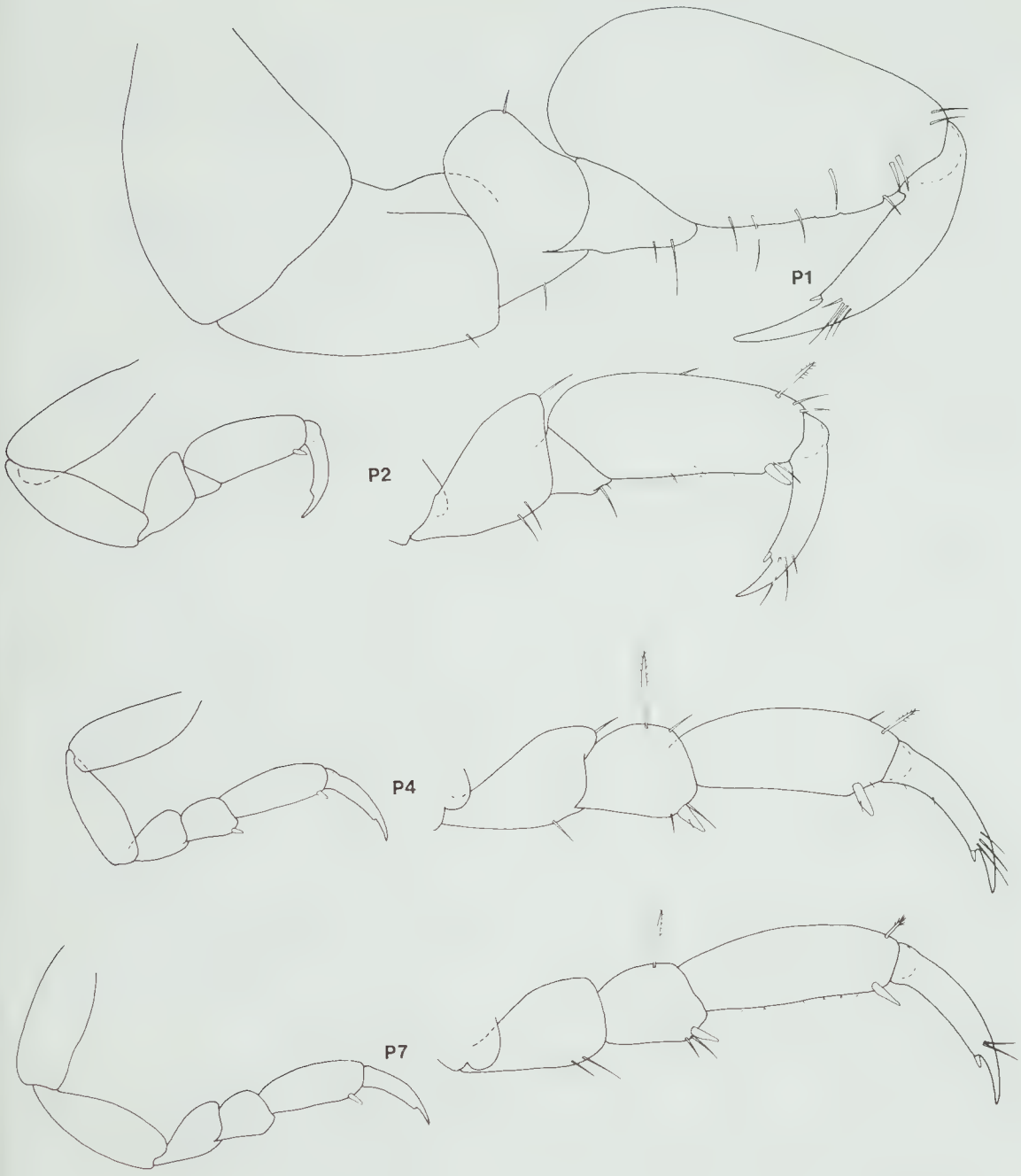

Figure 10. *Haliophasma dillwynia.* Holotype juvenile, 5.9 mm.

Distribution. Western Australia, North-west Shelf, 122-134 m.

Remarks. The smooth pereon and bullet-shaped telson distinguish *Haliophasma dillwynia* from the other species of this region.

Haliophasma elongatum Poore

Haliophasma elongatum Poore, 1975: 513-515, figs. 6, 7.—Negoescu and Wägele, 1984: 119.

Material examined. Tas., Sandy Bay, Derwent River off Nutgrove (42°54′S, 147°20′E), 18 Oct 1977, TM G2949(2 specimens).

NSW, east of Long Bay, 66 m, Australian Museum Shelf Benthic Survey stations, AM P24357, P22802. East of Malabar, 66 m, Australian Museum Shelf Benthic Survey stations, AM P22794-P22800, P22802-P22806.

Distribution. NSW and Tasmania, shelf and bays, 21-72 m.

Haliophasma pinnatum Poore

Haliophasma pinnatum Poore, 1975: 518-520, figs. 9, 10.—Negoescu and Wägele 1984: 119.

Material examined. NSW, Port Hacking (34°05′S, 151°10′E), New South Wales State Fisheries, AM P24354 (1 specimen), P32636(1).

Distribution. NSW central coast, shelf and bays, 28-66 m.

Haliophasma pugnatum Poore

Haliophasma pugnatum Poore, 1975: 521-523, figs. 11, 12.—Negoescu and Wägele 1984: 120.

Material examined. SA, N. of side West Island (32°31′S, 133°15′E), sand patch in *Heterozostera* meadow, 5 m, G.C.B. Poore and H.M. Lew Ton, Mar 1985, NMV J11976(1 specimen). Spencer Gulf, South Australian Fisheries, SAM.

Tas., Dover Jetty (43°19′S, 147°01′E), 2 m, muddy fine shell under *Zostera*, R.S. Wilson, NMV J11977(1).

Remarks. New records extend the range of this species from the Victorian coast to South Australia and Tasmania. All records are from less than 16 m depth.

Haliophasma swainsonia sp. nov.

Figures 11, 12

Material examined. 32 juveniles, 11 mancas; 4.3-13.2 mm.

Holotype: NSW, south-east of Legges Beach, Quarantine Bay, Twofold Bay (37°05′E), 8 m, dredge, S. Keable et al., 22 Feb 1985, AM P 36761 (with 1 slide), juvenile, 13.2 mm.

Paratypes: NSW, type locality, AM P36056(1 specimen). South-east of Legges Beach, Quarantine Bay, Twofold Bay, 5-11 m, S. Keable et al., 22 Feb 1985, AM P36133(2), P36134(3), NMV J12249(1). North-east of Boydtown Beach, Twofold Bay, 9 m, S. Keable et al., 22 Feb 1985, AM P36057(5). South of Oman Point, Quarantine Bay, Twofold Bay, 8 m, S. Keable et al., 22 Feb 1985, AM P36135(1).

Other material. Vic., 3 km off McGaurans Beach (38°23′S, 147°11′E), 18-20 m, J.E. Watson, 6 Mar 1980, NMV J14997 (1 specimen)

Description. Head and pereon smooth, with irregular pigment pattern. Head not as long as wide, tapering anteriorly, anterolateral lobes not swollen distally. Rostrum as long as anterolateral lobes, apex obtuse. Pereonite 1 without tubercles or bosses on posterior margin. Pereonite 7 wider than long, without anterior depressions. Pleon about as long as wide, 1.5 times as long as pereonite 7; pleonites with distinct lateral grooves, lacking pits and keels. Telson twice as long as broad, 1.3 times as long as pleon; broadest at midpoint, tapering evenly to gently rounded apex; dorsally domed, smooth and without keels.

Mandibular palp reashing tip of incisor, article 3 with 6 terminal setae. Maxillipedal palp article 2 barely exceeding first. Antenna 1, article 1 of peduncle not modified. Pereopod 1 subchelate, propodal palm oblique, smooth, setal rows dense. Uropodal endopod not reaching apex of telson, about 1.5 times as long as broad, broadest at base, tapering to a broadly rounded apex. Uropodal exopod not reaching to base of endopod, convex medially, lateral margin sinuous and crenellate, 3 times as long as wide. Uropodal peduncle produced medially.

Male. Not known.

Distribution. Southern New South Wales (Twofold Bay) and Victoria (McGaurans Beach) 5-20 m.

Remarks. Haliophasma swainsonia is the only Australian species of *Haliophasma* with persistent pigment pattern covering the entire dorsal surface.

Haliophasma syrtis Poore

Haliophasma syrtis Poore, 1975: 526-527, figs. 14, 15.—Negoescu and Wägele, 1984: 120.

Material examined. Qld, Moreton Bay, Middle Banks off Tangalooma (27°12′S, 153°22′E), S. Cook and S. Newlands, NMV J1577(1 specimen).

NSW, Ulladulla (35°21′S, 150°29′E), 80 m, coarse sand, K. Sheard, 9 Apr 1944, SAM(1).

Distribution. Southern Queensland and New South Wales, 12-80 m.

Haliophasma templetonia sp. nov.

Figures 13, 14

Material examined. 1 juvenile, 1 submale, 3 mancas; 5.5-13.0 mm.

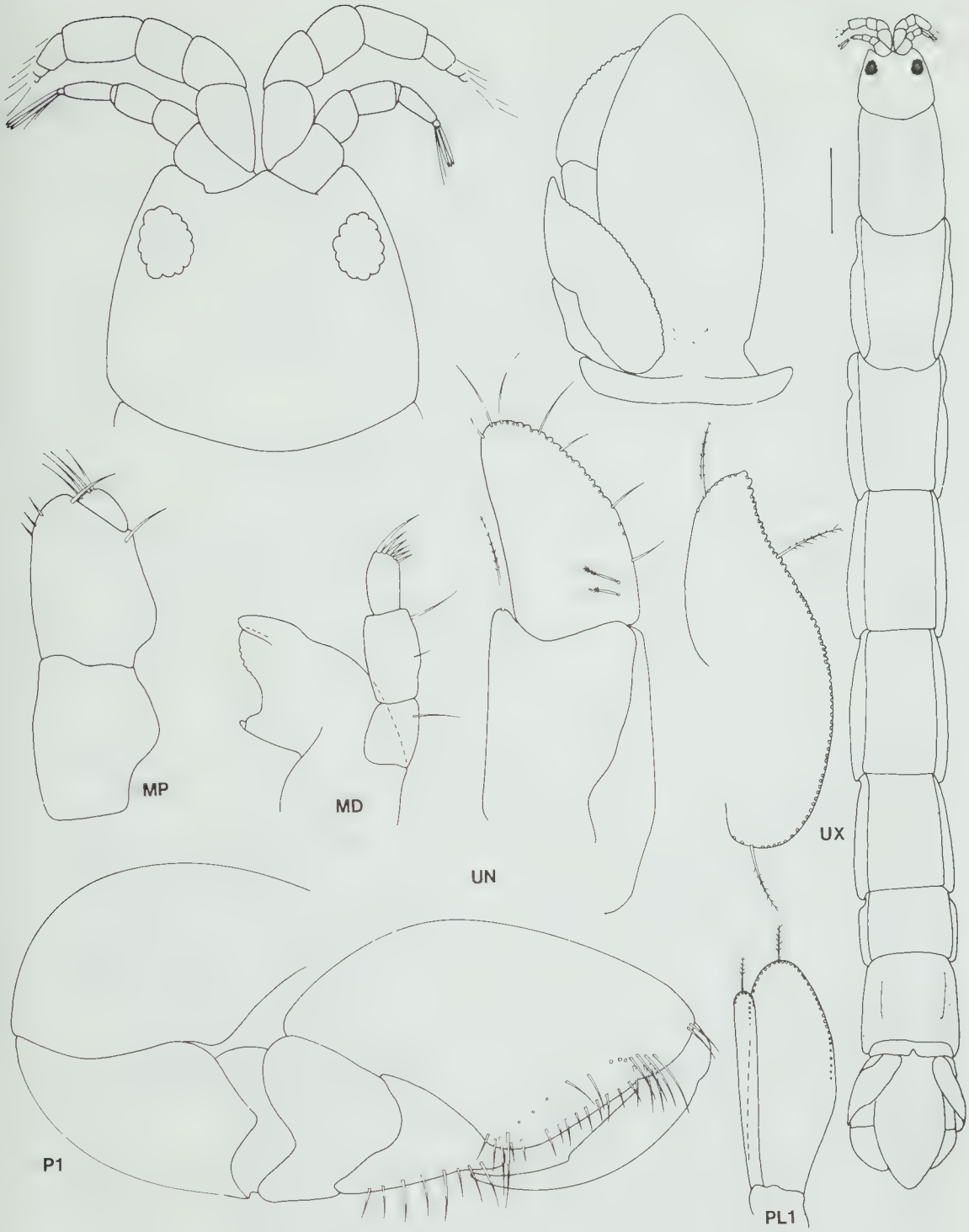

Figure 11. *Haliophasma swainsonia.* Holotype juvenile, 13.2 mm

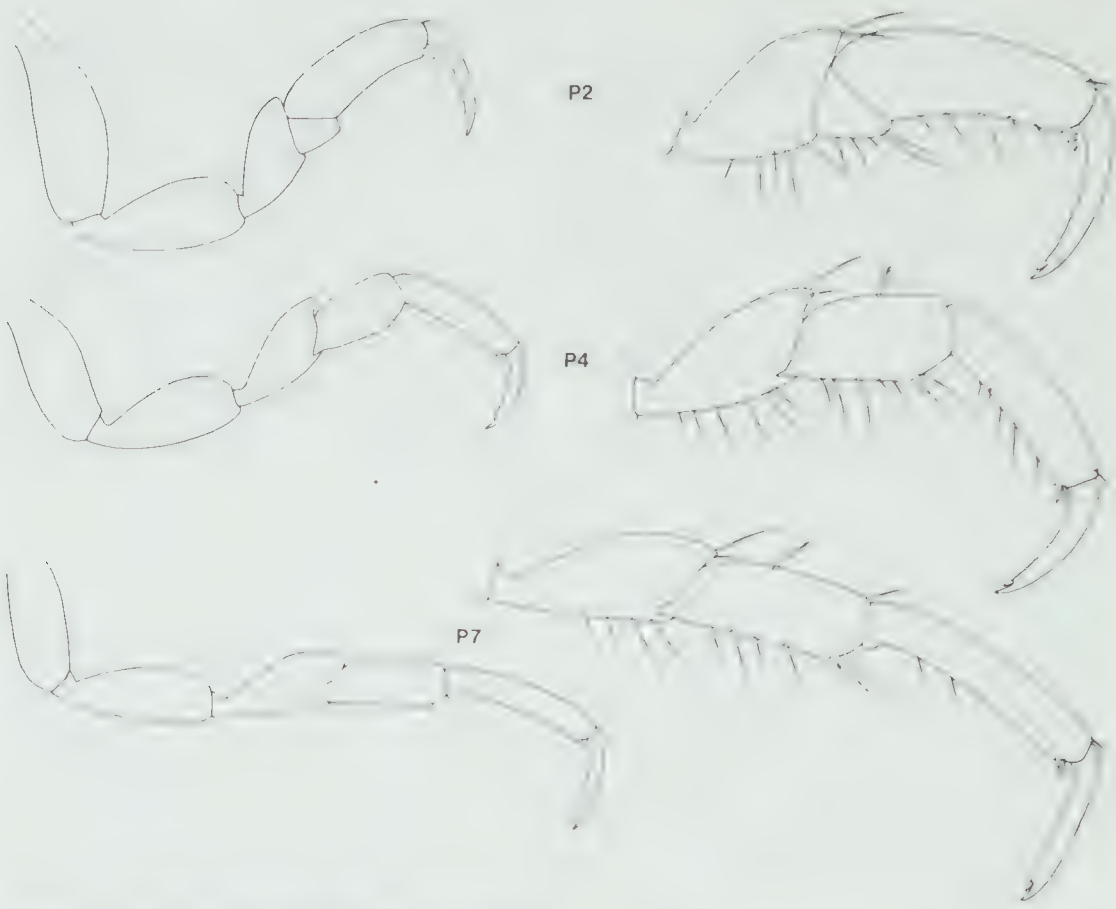

Figure 12. *Haliophasma swainsonia*. Holotype juvenile, 13.2 mm

Holotype: NSW, Munganno Point, Twofold Bay (37°05'S, 149°54'E), subtidal rock platform, 9 m, S. Keable et al., 19 Dec 1985, AM P36592, juvenile, 13.0 mm.

Paratypes: NSW, type locality, AM P36762 (2 mancas, 5.5 mm); type locality, 27 Mar 1985, AM P36061 (manca, 6.4 mm, with 1 slide). Murrumbulga Point, Twofold Bay (37°05'S, 149°54'E), subtidal rock platform, S. Keable et al., 29 Mar 1985, AM P36062 (1 submale).

Description. Head and pereon with scattered pits. Head about 1.3 times as long as wide; anterolateral lobes not swollen; rostrum as long as anterolateral lobes, apex acute. Pereonite 1 without bosses on posterior margin. Pereonites 4-6 with distinct elongate pits anteriorly. Pereonite 7 not as long as wide. Pleon about as long as wide, 1.5 times as long as pereonite 7. Pleonites 1-5 without obvious keels or distinct patterns of pitting. Telson 2.8 times as long as wide, 2.2 times as long as pleon; broadest as midpoint, barely tapering, with broad angular apex; with pair of dorsal keels defining central raised area.

Mandibular palp exceeding incisor by half its length, article 3 with 3 distal setae. Maxillipedal palp article 2 clearly exceeding first. Antenna article 1 not modified. Pereopod 1 subchelate, propodal palm axial and with small step distally; setal rows sparse. Uropodal endopod not reaching apex of telson, 1.3 times as long as wide, shorter than peduncle; broadest at midpoint, tapering to obtuse apex. Uropodal exopod reaching beyond peduncle, with distinct dorsal lobe; 2.1 times as long as wide, convex medially, lateral margin sinuous and crenellate.

Remarks. Only *Haliophasma cycneum, H. purpureum* and *H. yarra* have a uropodal peduncle with a distinct medio-distal lobe. *H. templetonia* can be distinguished from these species by the combination of ridged telson, short angular uropodal endopod and axial palm of pereopod 1. It is the only species of *Haliophasma* from a kelp holdfast; all others are from sedimentary environments.

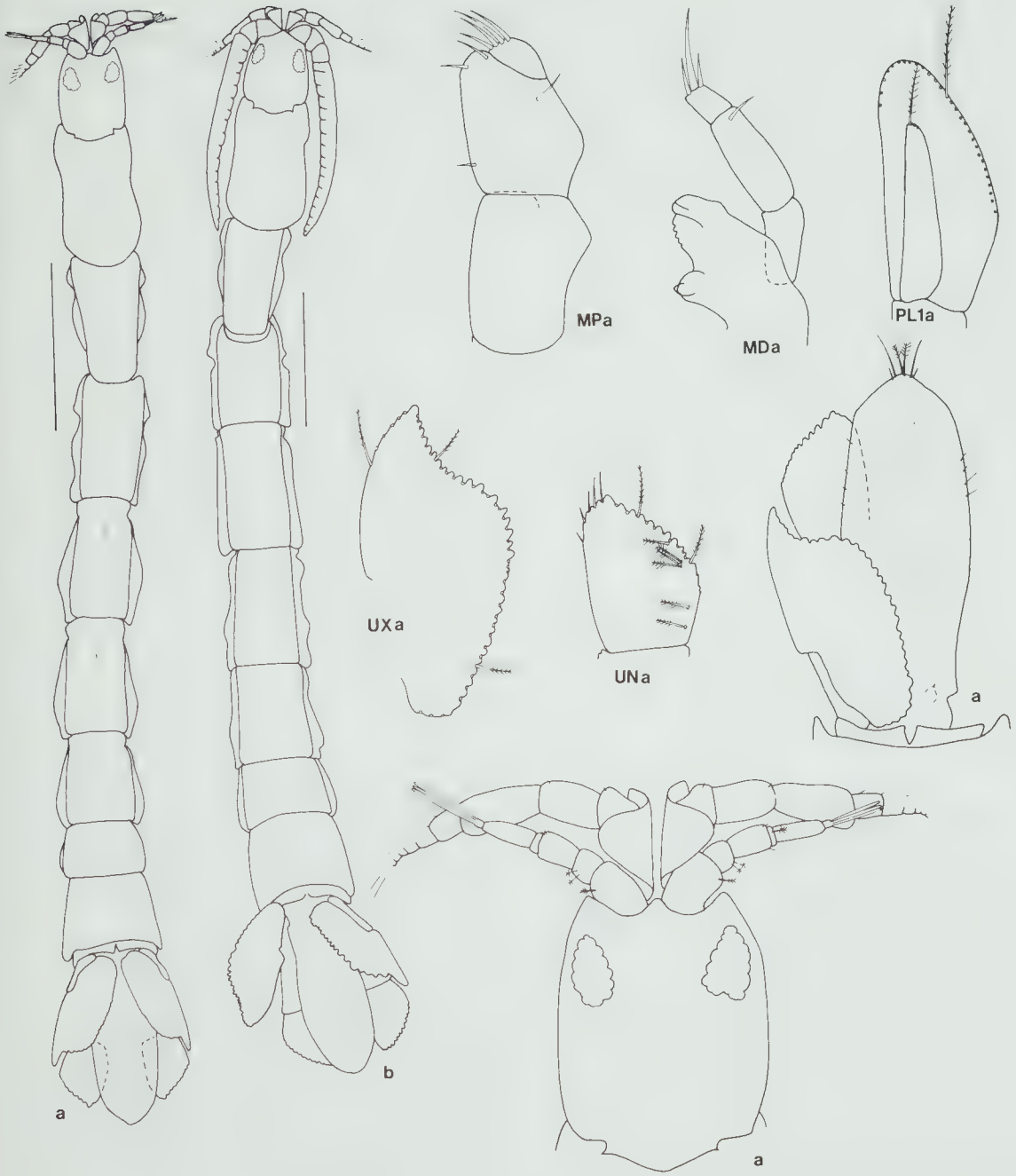

Figure 13. *Haliophasma templetonia.* a, paratype manca, 6.4 mm, AM P36061; b, paratype submale, 7.9 mm, AM P36062.

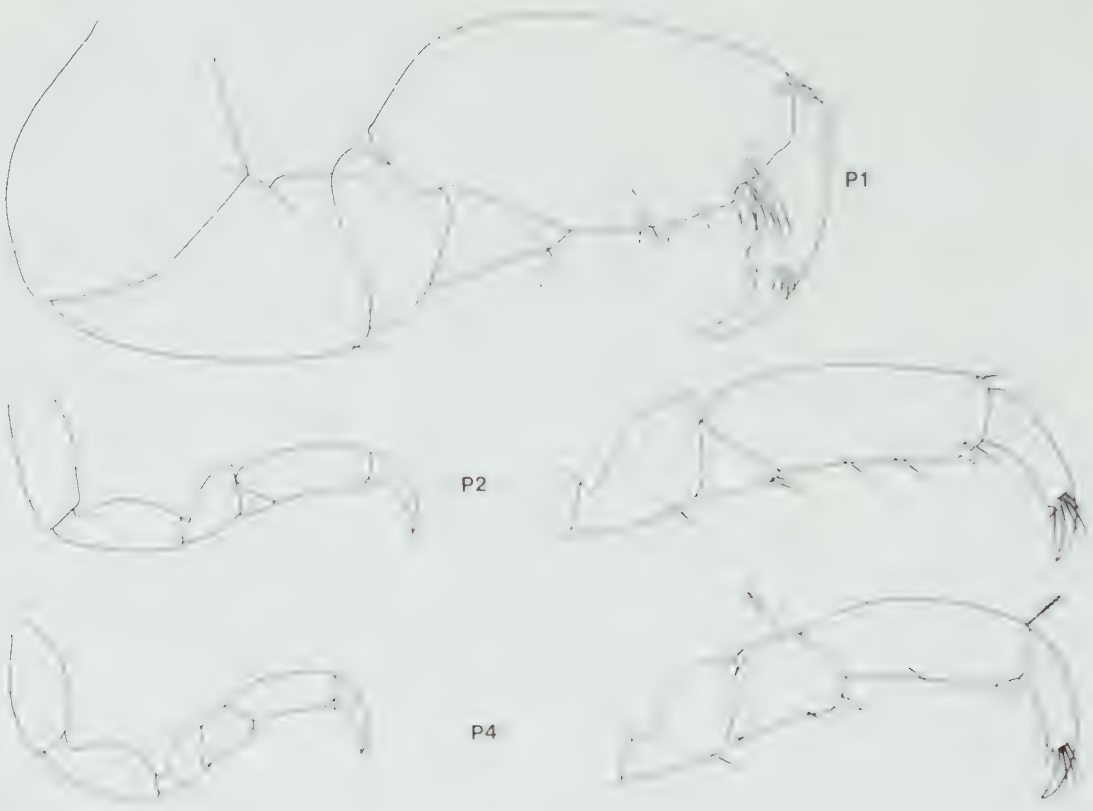

Figure 14. *Haliophasma templetonia.* Holotype manca, 6.4 mm.

Haliophasma yarra Poore

Haliophasma yarra Poore, 1975: 528-529, fig. 16.—Negoescu and Wägele, 184: 120.

Material examined. NSW, Port Hacking, New South Wales State Fisheries, AM(1 specimen); NMV J3059(1).

Bass Strait, south of Point Hicks (38°17.70′S, 149°11.30′E), 400 m, 24 Jul 1986, M.F. Gomon et al. on RV "Franklin", NMV J14465 (1).

Distribution. Bays in New South Wales and Victoria; eastern Bass Strait, 3-400 m.

Unidentified males

Figure 15

Material examined. 3 males.

North-west Shelf between Dampier and Port Hedland: 20°17′S, 116°38′E, 42 m, very coarse sandy shell, 10 Jun 1983 (stn NWA-43), NMV J12475(8.3 mm); 20°19′S, 117°20′E, 30 m, coarse shell and sand, 11 Jun 1983 (stn NWA-51), NMV J12476(9.4 mm); locality unspecified, CSIRO stn, NMV J13477(7.8 mm).

Remarks. Three adult male specimens from the North-west Shelf could not be assigned to any of the species described in this paper. They are illustrated to make clear the difficulties faced when attempting to identify isolated male specimens.

Acknowledgements

This contribution was made possible through an Australian Biological Resources Study grant from the Bureau of Flora and Fauna, Canberra. We are especially grateful to G. Milledge who inked the figures. For the loan of materal we thank J. Lowry (Australian Museum), W. Zeidler (South Australian Museum), T. Ward (CSIRO Division of Fisheries) and P. Arnold (James Cook University).

The Australian Institute of Marine Science, Townsville, and CSIRO Division of Fisheries, Hobart, allowed us to join their cruises on the Great Barrier Reef and the North-west Shelf. The Museum of Victoria collections from Bass Strait

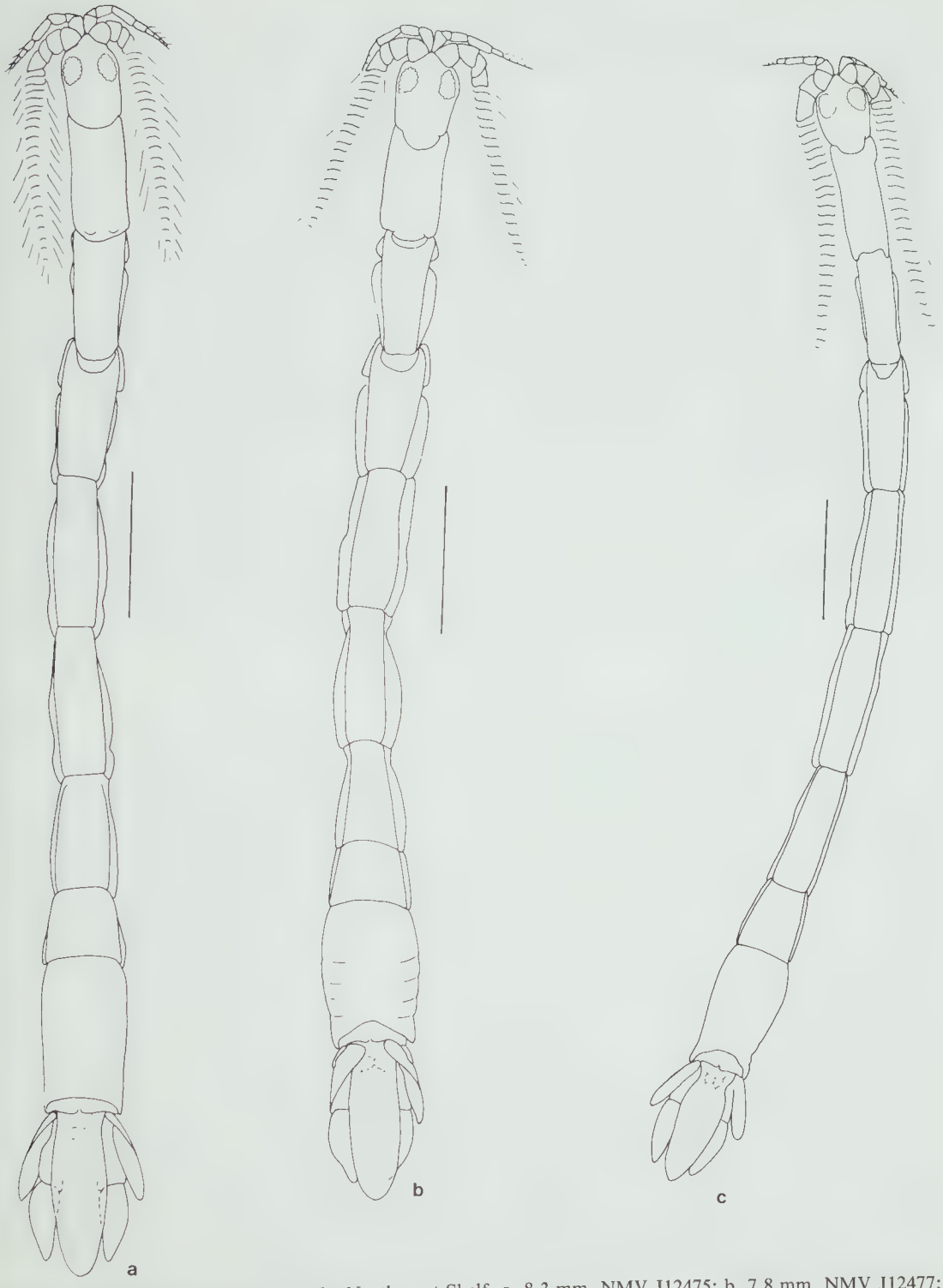

Figure 15. Unidentified males from the North-west Shelf. a, 8.3 mm, NMV J12475; b, 7.8 mm, NMV J12477; c, 9.4 mm, NMV J12476.

and the Tasmanian coast were made possible by Marine Sciences and Technologies grants to the Museum of Victoria. We are grateful to R. Wilson for processing these samples.

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AMAKUSANTHURA AND *APANTHURA* (CRUSTACEA: ISOPODA: ANTHURIDAE) WITH NEW SPECIES FROM TROPICAL AUSTRALIA

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Abstract

Poore, G.C.B. and Lew Ton, H.M. 1988. *Amakusanthura* and *Apanthura* (Crustacea: Isopoda: Anthuridae) with new species from tropical Australia. *Memoirs of the Museum of Victoria* 49: 107-147.

The genera *Amakusanthura* and *Apanthura* are redefined. *Apanthuretta* Wägele is synonymised with *Amakusanthura*. A key to known Australian species of *Amakusanthura, Apanthura* and the related genus *Apanthuropsis* is presented.

Amakusanthura coppingeri (Barnard), 13 new species of *Amakusanthura* Nunomura (*A. agonis, A. angophora, A. brachyscome, A. dodonaea, A. eugenia, A. goodenia, A. hibbertia, A. kingia, A. lechenaultia, A. melaleuca, A. pandorea, A. tristania* and *A. wahlenbergia*) and four new species of *Apanthura* Stebbing (*A. kennedia, A. pultenaea, A. restio* and *A. stipa*) are described from sedimentary and reef environments of tropical Australia.

It is noted that oostegite-bearing females have never been recorded for either of these two genera and that their reproductive process is unknown. The tropical fauna described here does not include any of the species known from south-eastern Australia but its extent across northern Australia is unclear. *Amakusanthura* is richest in species in tropical bays and *Apanthura* richer in temperate habitats.

Introduction

Recently we described from south-eastern Australia nine new species of *Apanthura* Stebbing and three new species of *Apanthuretta* Wägele (Poore and Lew Ton, 1985). More lately it has been realised that *Apanthuretta* is a junior synonym of *Amakusanthura* Nunomura and that this genus is widespread, abundant and rich in species in tropical Australia. This paper describes 13 new species of *Amakusanthura,* redescribes *A. coppingeri* (Barnard), and describes four new species of *Apanthura* from this region.

A key to the identification of all Australian species of *Amakusanthura* and *Apanthura* and the related genus *Apanthuropsis* is presented.

The material for this contribution has come from our own collections and others acknowledged at the end of the paper. A large part was made available to us by Alastair Birtles and Peter Arnold, James Cook University of North Queensland, whose Three Bays Survey (TBS) was carried out between 1974 and 1977 near Townsville. Most is lodged in the Museum of Victoria, Melbourne (NMV), with representative specimens in the Australian Museum, Sydney (AM), the Northern Territory Museum, Darwin (NTM), and the Queensland Museum, Brisbane (QM). Specific epithets have been chosen from genera of the Australian flora and are used as nouns in apposition. This follows a pattern established for *Paranthura* by Poore (1984). The abbreviations P1-P7 are used for pereopods 1-7 and UN and UX for uropodal endopod and exopod. The head with antennae and pleon and telson are figured in dorsal and often in lateral view.

Each species is illustrated fully rather than being described in words in detail. Instead short diagnoses are given with remarks on critical specific characters. Mouthparts are not figured because they provide little useful taxonomic information. Mouthparts typical of the genus were figured by Poore and Lew Ton (1985) and Wägele (1981a).

The new species are distinguished by subtle differences in the shape of the telson, uropods and pereopods. The elongation of the telson and uropods of males of *Amakusanthura* made them difficult to assign to species reliably. This is in contrast to males of *Apanthura* which are often highly

and individually modified and greatly help in distinguishing species. The collections of the Museum of Victoria and the Australian Museum contain registered unidentified males of both genera from all the regions and habitats sampled. Identification of males from the bays near Townsville where several species co-occur was particularly difficult.

In this study, as in our work on south-eastern Australian species, several hundred individuals of the two genera were examined and identified. Of 399 tropical specimens 34 (9%) were fully adult males or submales. Submales have multiarticulate antenna 1 flagella but lack aesthetascs and fully developed appendices masculinae. No oostegite-bearing females were found. Females are relatively abundant in many other anthurid genera but their absence in collections of *Apanthura, Amakusanthura* and incidentally of *Haliophasma* raises questions about the reproductive process in these genera. Swollen (possibly gravid) juveniles and mancas are frequent but more careful sampling and life history studies are required to determine how brooding takes place, if it occurs at all.

Distribution

This study brings to 17 the number of species of *Amakusanthura* known from Australia and to 13 the number of species of *Apanthura*. Even given that sampling of different habitats and areas of the coast is uneven some trends in the distribution of genera and species are apparent.

The most intensively sampled areas are Victorian bays and shelf, bays in New South Wales, Moreton Bay and bays near Townsville, Queensland, the North-west Shelf and some islands of the Great Barrier Reef. In general species of both genera are more common in muddy bays than in coarser sediments of the shelf. None is found in estuarine environments. Most species are locally endemic, tropical and temperate faunas being totally exclusive.

The three bays near Townsville comprise the area richest in species, especially of *Amakusanthura*. Only one of these also occurred on the North-west Shelf. Although the North-west Shelf was probably less intensively sampled for small animals than elswhere, samples from this region are rich in other isopods. The initial indication therefore is that the eastern tropical shelf is richer in species of *Amakusanthura* than the west and is richer than temperate regions. Because the north coast is virtually unknown the northerly and westerly limits of this fauna are unknown. Interestingly, the only species known from deep-water sediments of northern Australia (*A. coppingeri*) was rediscovered in the north-west but not near Townsville. For similar reasons the southern limits of species of *Amakusanthura* are unknown but only one occurs as far south as Moreton Bay, southern Queensland.

It appears that *Amakusanthura* is most diverse in tropical sediments, especilly in north Queensland, while *Apanthura* is more diverse in temperate environments.

Amakusanthura Nunomura

Amakusanthura Nunomura, 1977: 79-80.

Apanthuretta (nomen nudum) Wägele, 1981a: 85, 112, fig. 37.

Apanthuretta Wagele, 1981b: 134-5.—Poore and Lew Ton, 1985: 136.

Diagnosis. Integument smooth, sometimes pigmented. Eyes present or not visible. Antenna 1 flagellum short, of 3 articles, the last short, bearing 3 aesthetascs. Antenna 2 flagellum short, of 2-4 articles. Mandibles symmetrical, not sexually dimorphic; incisor, lamina dentata and blunt molar present; palp 3-articled, article 3 one-third length of article 2 and with 3-4 terminal setae. Maxilliped bearing an acute filamentous endite with terminal seta; palp of 3 articles, article 1 wider than long; article 2 usually with a row of mesial setae; article 3 oblique, subterminal, much smaller than 2, with 4-5 apical setae.

Pereopod 1, propodal palm stepped (sometimes weekly toothed), with stout mesial setae. Pereopods 2 and 3 with propodus only little more robust than on posterior pereopods. Pereopods 4-7 with triangular-trapeziform carpus, with free anterior margin.

Pleon longer than wide; pleonites fused or often pleonites 1-4 separated dorsally by shallow integumental grooves, 4-5 fused dorsally.

Uropodal endopod as long as peduncle, its margin setose; exopod narrow and with a sinuous dorsal margin, or with an obscure dorsal lobe.

Male head smaller than in juvenile, with broadened flattened rostrum, antenna 1 flagellum with more than 10 isometric articles each bearing numerous aesthetascs, much longer than head. Male pereopod 1 not grossly modified. Telson narrower, with mid-dorsal longitudinal depression.

Type species. Amakusanthura longiantennata Nunomura, 1977 (original designation).

Remarks. This diagnosis is essentially Poore and Lew Ton's (1985) diagnosis of *Apanthuretta* updated to make it comparable with that required to diagnose all other anthurid genera. Examination of the holotype of *Amakusanthura longiantennata*

Key to Australian species of *Apanthura, Apanthuropsis* and *Amakusanthura*

This key will distinguish anthurid species in which the maxillipedal palp is of three articles and the carpus of pereopods 4-7 is triangular, not rectangular. Species are distinguished by very subtle differences which are often difficult to quantify; the user is advised to consult the figures when in doubt. Special care should taken with interpretation of the shape of the telson, uropodal rami and the propodus of pereopod 1. Species marked * are from south-eastern Australia and were figured and described by Poore and Lew Ton (1985). *Apanthura zeewykae* was described from the Houtman Abrolhos Islands, Western Australia, by Kensley and Poore (1982).

1. Pereopods 2 and 3 with propodus little smaller than that of pereopod 1, ovoid; maxilliped without endite, article 3 longer than wide; mandibles asymmetrical, molars fitting as tooth and socket .... *Apanthuropsis richea**
— Pereopods 2 and 3 with propodus different from that of pereopod 1, elongate; maxilliped with endite, article 3 wider than long or barely longer than wide; mandibles symmetrical, with flat opposing molars 2
2. Pleonites 1-5 indistinguishable dorsally (except in some males); male antenna 1 flagellum of about 10 articles ..... *Apanthura* . . . 3
— Pleonites, except 4-5, distinguished by dorsal grooves (rarely 1-5 indistinguishable); male antenna 1 flagellum of at least 15 (usually about 20) articles ..... *Amakusanthura* . . . 16
3. Pereopods 2-7 having merus and carpus (and propodus to lesser extent) posteriorly convex and richly setose; antenna 1, article 2 with at least 6 long lateral setae; uropodal endopod having distal and lateral setal rows separated by distinct hiatus 4
— Pereopods 2-7 merus-propodus with straight posterior margins and few setae; antenna 1, article 2 with fewer than 3 long lateral setae; uropodal endopod having continuous distolateral setal row 6
4 Telson having lateral margins convex, dorsal setae in pairs near midline; male pereopod 1 with a palmar tooth ..... *Apanthura callitris**
— Telson having lateral margins straight or concave distally, dorsal setae near margin; male pereopod 1 without a palmar tooth 5
5. Telson tapering from proximal third; male pereopod 2 with a truncate blade on palm and setose triangular carpus; male pereonite 1 without ventral keel ..... *Apanthura lambertia**
— Telson tapering only on distal third; male pereopod 2 with straight palm and strong lobe on carpus; male pereonite 1 with ventral keel ..... *Apanthura isotoma**
6. Pleonal grooves visible dorsolaterally 7
— Pleonal grooves visible only ventrolaterally 8
7. Not pigmented; male pereopod 1 without palmar tooth, carpus expanded as a tooth opposing dactylus ..... *Apanthura mirbelia**
— Pigmented; male pereopod 1 not as above *Apanthura stipa* (figs. 35, 36)
8. Pereopod 1 propodus 1.5 times as long as greatest width; telson with narrowly rounded apex ..... *Apanthura zeewykae*
— Pereopod 1 propodus twice as long as greatest width; telson with broadly rounded apex..... 9
9. Uropodal endopod about 1.3 times as long as wide; telson with transverse row of long setae at two-thirds mark .. *Apanthura restio* (figs. 33, 34)
— Uropodal endopod more than 1.5 times as long as wide; telson with scattered long setae on distal third 10
10. Pigmented; telson 2.5 times as long as wide; pereopod 1 palm oblique, with well developed conical tooth; male with large ventral swelling at base of maxillipeds; male pereopod 1 with strong tooth on pereopod 1 ..... *Apanthura xanthorrhoea**

– Not pigmented; telson less than twice as long as wide (rarely more so); pereopod 1 palm axial, with small conical tooth; male with poorly developed chin or none; male pereopod 1 with tooth on carpus similar to juvenile . 11

11. Telson with numerous lateral setae on distal third; head with prominent ventral lobe at base of maxillipeds ..... *Apanthura thryptomene**

– Telson with 1-2 pairs of lateral setae about three-quarters way along; head without ventral lobe 12

12. Telson 2.3 times as long as wide 13

– Telson twice as long as wide 14

13. Pereopod 1 palm axial, long, with tooth ..... *Apanthura drosera**

– Pereopod 1 palm oblique, short, with step *Apanthura kennedia* (figs. 29, 30)

14. Telson with narrowed triangular posterior half; uropodal endopod twice as long as wide, tapering ..... *Apanthura pultenaea* (figs. 31, 32)

– Telson with rounded apex; uropodal endopod less than twice as long as wide, moderately tapering 15

15. Antenna 1, article 2 with 1 short lateral seta; telson apex broadly rounded ..... *Apanthura styphelia**

– Antenna 1, article 2 with 2-3 long lateral setae; telson apex narrowly rounded ..... *Apanthura banksia**

16. Pleonites 1-5 not separated by transverse grooves 17

– Pleonites 1-4 separated by tranverse grooves 18

17. Telson with few distal setae, lateral margins convex ..... *Amakusanthura agonis* (figs. 2, 3)

– Telson with numerous distal setae, lateral margins angular ..... *Amakusanthura angophora* (figs. 4, 5)

18. Uropodal endopod exceeding telson (except in males) 19

– Uropodal endopod as long as or shorter than telson 23

19. Telson with concave lateral margin about two-thirds way along; adults not longer than 7 mm 20

– Telson with straight or convex lateral margins distally; adults longer than 8 mm 21

20. Uropodal endopod more than twice as long as wide; narrowed posterior portion of telson almost half total length; pereopods 4-7, propodus rectangular ..... *Amakusanthura wahlenbergia* (figs. 27, 28)

– Uropodal endopod less than twice as long as wide; narrowed posterior portion of telson one-third total length; pereopods 4-7, propodus tapering ..... *Amakusanthura goodenia* (figs. 13, 14)

21. Telson with straight distolateral margins, with 2 longitudinal rows of setae distally ..... *Amakusanthura coppingeri* (figs. 7, 8)

– Telson with convex distolateral margins, with few dorsal setae 22

22. Telson apex broad, lateral margins thin and expanded; telson as long as pleon ..... *Amakusanthura melaleuca* (fig. 22)

– Telson apex narrow, lateral margins not thin; telson longer than pleon ..... *Amakusanthura pimelia**

23. Uropodal exopod with distal notch or dorsal margin decidedly discontinuous; adults longer than 14 mm 24

– Uropodal exopod dorsal margin convex, at most a shallow concavity distally; adults usually less than 10 mm 25

24. Telson strongly domed; pereopods richly setose posteriorly ..... *Amakusanthura hibbertia* (figs. 16, 17)

– Telson not strongly domed; pereopods with few posterior setae ..... *Amakusanthura pandorea* (figs. 23, 24)

25. Telson with broadly rounded apex (e.g., fig. 9) 26

– Telson with acutely rounded apex (e.g., fig. 12) 29

26. Telson apex with distally upturned rim 27

— Telson apex not upturned 28
27. Telson apex very broad, almost truncate; uropodal endopod 1.5 times as long as wide ..... *Amakusanthura brachyscome* (fig. 6)
— Telson apex only moderately broad; uropodal endopod twice as long as wide ..... *Amakusanthura dodonaea* (figs. 9, 10)
28. Telson slightly domed; pereopod 1 palm without tooth .... *Amakusanthura tristania* (figs. 25, 26)
— Telson strongly domed; pereopod 1 palm with definite step .... *Amakusanthura olearia**
29. Telson as long as pleon; pereopod 1 palm without tooth; uropodal exopod with convex dorsal margin ..... *Amakusanthura kingia* (figs. 18, 19)
— Telson longer than pleon; pereopod 1 palm with tooth or step 30
30. Telson flat, about twice as long as wide; uropodal exopod about twice as long as wide ..... *Amakusanthura eugenia* (figs. 11, 12)
— Telson domed, 2.5 times as long as wide; uropodal exopod more than twice as long as wide 31
31. Uropodal exopod with dorsal margin sinuous; telson apex moderately broadly rounded ..... *Amakusanthura correa**
— Uropodal exopod with distinct distal notch in dorsal margin; telson apex narrowly rounded ..... *Amakusanthura lechenaultia* (figs. 20, 21)

Nunomura, 1977 revealed few differences from more typical *Apanthuretta*. The holotype is a male differing from species assigned to *Apanthuretta* only in the absence of pleonal grooves. Although Numomura noted "demarcation of pleonal somites visible" and figured partial sutures we could see none on his specimen. The pleon is longer than wide as figured by Nunomura (and as in *Apanthuretta*). We refigure pereopod 1 (Fig. 1) to show the stout mesial setae typical of species previously assigned to *Apanthuretta*. The telson and maxilliped are lost. Pleonal grooves were discussed by Kensley (1980) and again by Poore and Lew Ton (1985). It is now our view that the grooves are not of generic value; they are absent in some Australian species as well as in *A. longiantennata*. Besides, *A. longiantennata* shows no unique apomorphy which might suggest that it is generically different. We are forced therefore to synonymise *Apanthuretta* with *Amakusanthura*.

Species removed from *Apanthura* or *Apanthuretta* to *Amakusanthura* are: *Apanthura africana* Barnard, 1914, *A. californiensis* Schultz, 1964, *A. coppingeri* Barnard, 1925, *A. dubia* Barnard, 1914, *A. inornata* Miller and Menzies, 1952, *A. libyana* Negoescu, 1980, *A. magnifica* Menzies and Frankenberg, 1966, *A. mana* Kensley, 1979, *A. motasi* Negoescu, 1980, and *A. significa* Paul and Menzies, 1971; and *Apanthuretta correa* Poore and Lew Ton, 1985, *A. lathrida* Wägele, 1981, *A. pimelia* Poore and Lew Ton, 1985, *A. pori* Wägele, 1981, and *A. olearia* Poore and Lew Ton, 1985. Full synonymies were given by Negoescu and Wägele (1984) or Poore and Lew Ton (1985).

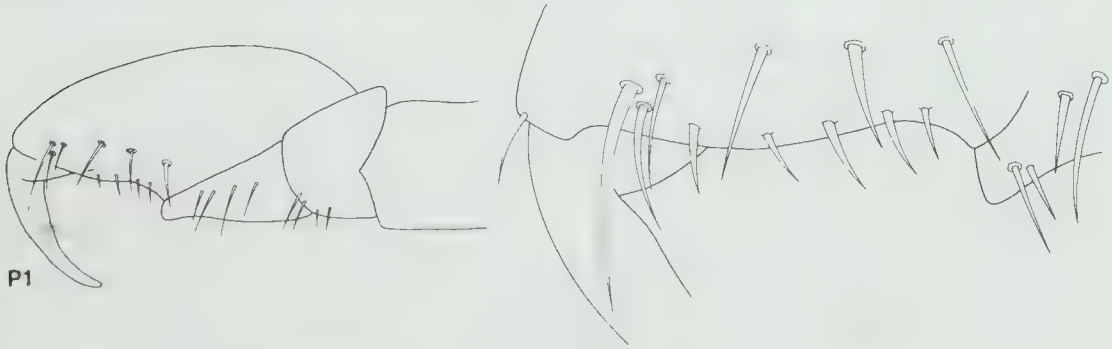

Figure 1. *Amakusanthura longiantennata*. Holotype male.

Amakusanthura is differentiated from the related genus *Apanthura* by a more elongate pleon and by a long male antennal flagellum. The similarities of *Apanthuretta* (and therefore of *Amakusanthura*) to other anthurid genera were discussed by Poore and Lew Ton (1985).

Amakusanthura agonis sp. nov.

Figures 2, 3

Material examined. 49 juveniles; 5.4-12.0 mm.

Holotype. Juvenile, 10.2 mm, NMV J12254(with slide). Qld, Cleveland Bay (19°11′S, 146°53′E), coarse silt, P. Arnold, 8 Oct 1975 (TBS stn).

Paratypes. Qld, Bowling Green Bay, Cleveland Bay and Halifax Bay, silt, 5-13 m (TBS stns), NMV J12250-J12253, J12255-J12265, J12267, J12269, J12272-J12278(31 specimens); AM P36770(1), P36771(1); QM W12163(1).

Other material. Qld, same localities, NMV collections(8); QM W12164(1). Triangular Island (22°23′S, 150°30′E), J. Lewis, 1981-1982, NMV J12279-J12282(4).

WA, North-west Shelf, 19°58′S, 117°49′E, 42 m, 26 Jun 1983, (CSIRO stn D2), NMV J12283(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm oblique, distally straight, without tooth, mesial surface concave. Pereopod 2 carpus with roundly lobed posterodistal margin. Pleon with deep lateral epimera but no dorsal grooves. Uropodal endopod shorter than telson, triangular, little longer than wide, lateral margin oblique. Exopod 2.7 times as long as wide, dorsal margin sinuous, with no dorsal lobe. Telson strongly and broadly domed, its highest point almost flat, tapering to broad apex, lateral flanges narrow, with few dorsal setae.

Male. Unknown.

Distribution. Central Queensland, bays, 5-13 m, silty sediments; North-west Shelf, 42 m.

Remarks. Amakusanthura agonis, one of the larger tropical species of the genus, is recognised by the strongly domed telson and especially narrow uropodal exopod. *Amakusanthura agonis* is one of only two Australian species of the genus (the other being *A. angophora*) in which pleonal grooves are not seen. It differs from *A. angophora* in having fewer setae on the telson. Although this species lacks dorsal pleonal grooves it is not a member of *Apanthura.* Its elongate pleon, narrow uropodal exopod and simple palm on pereopod 1 are typical of *Amakusanthura.* Unfortunately males are unknown so confirmation from antenna 1 is not possible.

The species is the most abundant of all *Amakusanthura* in the Townsville bays. Most of the material comes from the area around Townsville but a single specimen from the North-west Shelf which could not be distinguished from the rest suggests the species may be widespread in tropical Australia. If so it is the only species of the genus so distributed.

Amakusanthura angophora sp. nov.

Figures 4, 5

Material examined. 3 submales, 18 juveniles; 4.1-8.8 mm.

Holotype. Juvenile, 7.7 mm, NMV J12291(with slide). Qld, Halifax Bay (19°08′S, 146°43′E), 7 m, coarse silt, P. Arnold, 10 Dec 1975 (TBS stn).

Paratypes. Qld, Bowling Green Bay, Cleveland Bay and Halifax Bay, silt and very fine sand, 3-11 m (TBS stns), NMV J12287-J12290(5), J12292(1), J12293(1), J12295(1), J12296(1), J12297(submale, 8.2 mm), J12298(1), J12300(2 submales); AM P36772(1), P36773(1); QM W12165(1).

Other material. Qld, same localities, NMV and QM collections(3).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm slightly oblique, proximally convex and distally concave, without tooth. Pereopod 2 carpus with angled posterodistal margin. Pleon with deep lateral epimera but no dorsal grooves. Uropodal endopod shorter than telson, triangular, apex obliquely truncate, about 1.2 times as long as wide. Exopod 2.5 times as long as wide, dorsal margin essentially convex, with no dorsal lobe. Telson dorsally flat over most of width and steep sided, tapering to a broadly rounded apex, with thin angled lateral flanges at widest point, distally especially setose.

Male. Only submale known. Antenna 1 flagellum of 15 articles reaching to posterior margin of pereonite 2. Head reduced and with enlarged eyes. Pereon, pleon and pereopods much as in juvenile. Telson with a narrow mid-dorsal depression.

Distribution. Central Queensland, bays, 3-11 m, silty and fine sand sediments.

Remarks. Amakusanthura angophora is most easily separated from *A. agonis* with which it co-occurs by its very flat setose telson. Both lack pleonal sutures but are not members of *Apanthura* because of their elongate pleons, narrow uropodal exopods and simple pereopod 1 palm. The submale of this species has a 15-articled antennal flagellum, longer than typical of *Apanthura.*

Amakusanthura brachyscome sp. nov.

Figure 6

Material examined. 1 submale, 19 juveniles; to 9.6 mm.

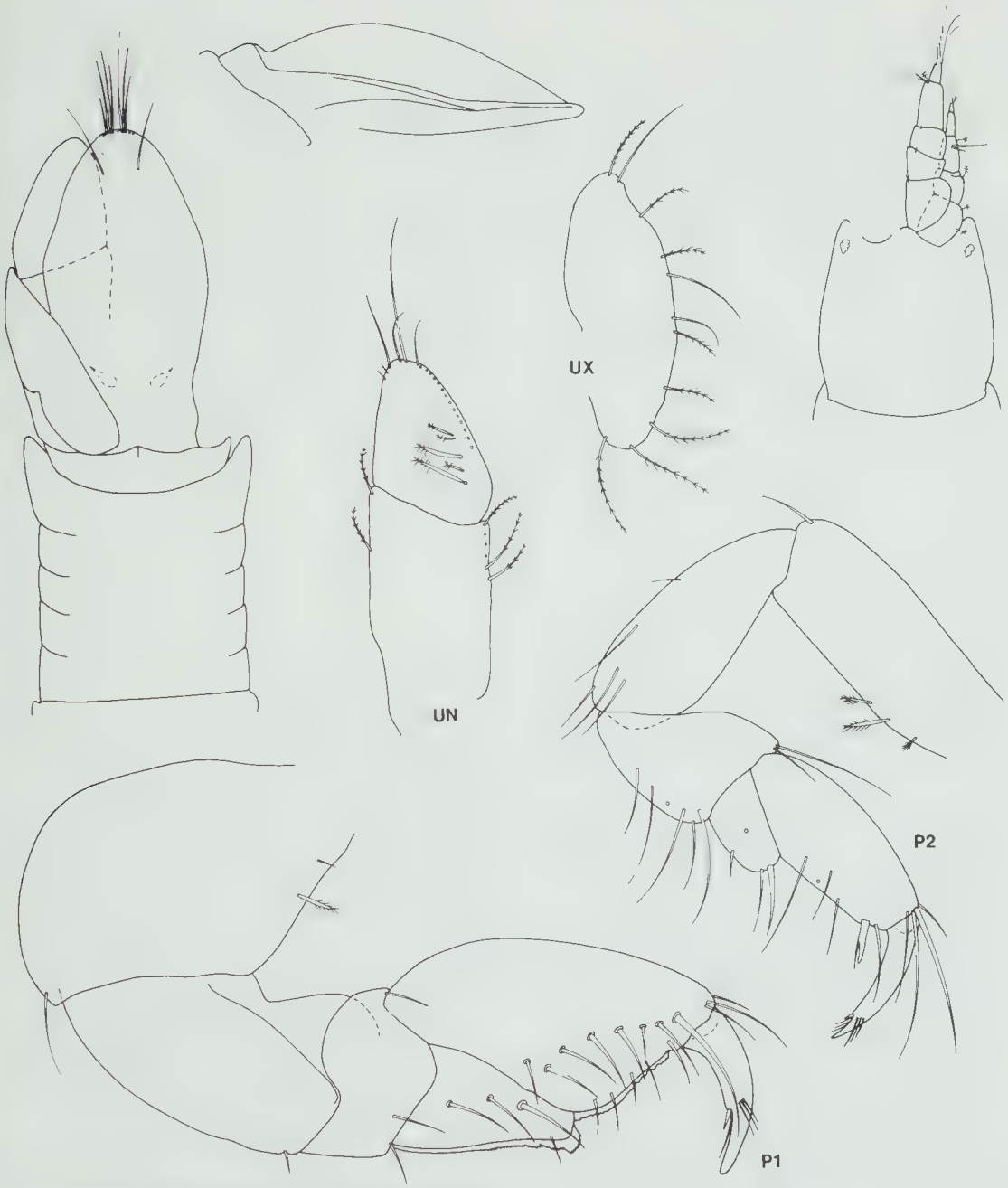

Figure 2. *Amakusanthura agonis.* Holotype juvenile.

Holotype. Juvenile, 9.6 mm, NMV J12301. Qld, Townsville bays, P. Arnold, 1974-1977 (unrecorded TBS stn).

Paratypes. Qld, Bowling Green Bay and Halifax Bay, 3 m (TBS stns), NMV J12302-J12304(3); AM P36766(1). Triangular Is. (22°23′S, 150°30′E), J. Lewis, 1981-1982, NMV J12305(1), J12306(1). Middle Banks, Moreton Bay, S Cook, 1984, NMV J12307(7), J12308(submale); QM W12167(5).

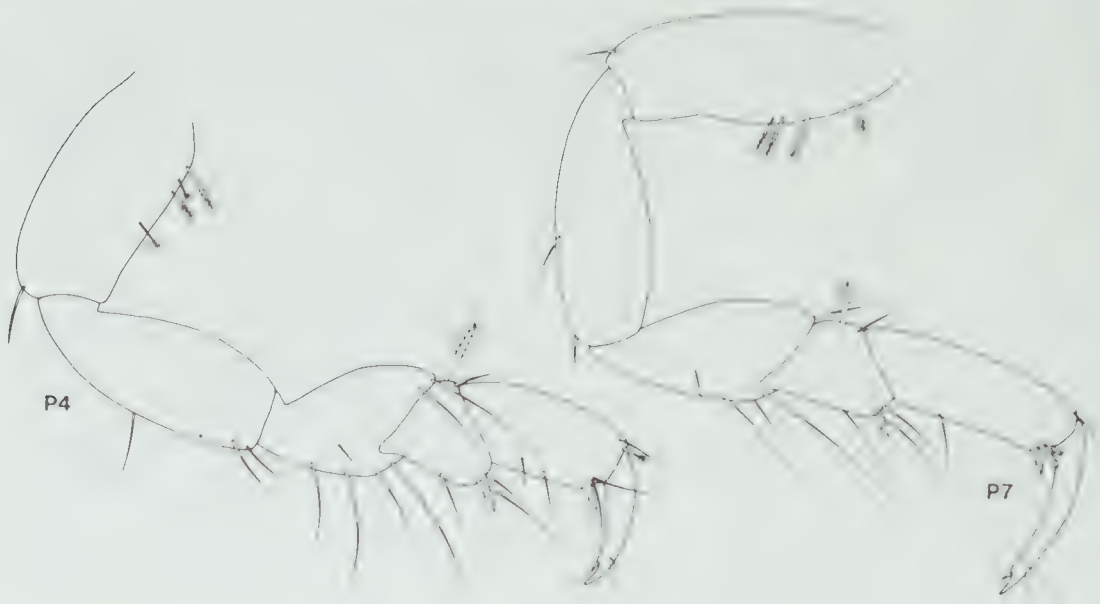

Figure 3. *Amakusanthura agonis*. Holotype juvenile.

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin parallel to carpal suture over most of its length, length 2.1 times width; palm oblique, short, with strong step at midpoint. Pereopod 2 carpus with roundly lobed posterodistal margin; propodus strongly tapering. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod as long as telson, triangular-ovoid, apex rounded, 1.3 times as long as wide. Exopod 2.4 times as long as wide, with a long broad distoventral lobe and sinuous dorsal margin. Telson slightly dorsally domed proximally, more concave distally, tapering to a very broad apex, lateral margins gently convex, with few dorsal setae.

Distribution. South and central Queensland, shallow bay sediments.

Remarks. Amakusanthura brachyscome is distinguished by its broad and distinctly upturned telsonic apex. It is similar to *A. dodonaea* which has a narrower telson and narrower uropodal endopod. This is the only tropical species of the genus distributed as far south as Moreton Bay.

Amakusanthura coppingeri (Barnard)

Figures 7, 8

Paranthura australis.—Miers, 1884: 311.—Haswell, 1884: 1012 (not Haswell, 1881, nomen dubium).

Apanthura coppingeri Barnard, 1925: 142, pl. 4 fig. 12.—Nierstrasz, 1941: 241.

Apanthuretta coppingeri.—Poore and Lew Ton, 1985: 136.

Material examined. 3 juveniles; 7.8-9.0 mm.

Holotype. Juvenile, BMNH 1882.7, Northern Territory, Dundas Strait (11°22′S, 131°40′E), 17 fm (31 m), "Alert" collection.

Other material. NT, Oxley Is. (11°00′S, 132°49′E), 14 m, muddy sand, G.C.B.Poore, 21 Oct 1982, NTM Cr4067(1).

WA, North-west Shelf, 19°29′S, 118°53′E, 40 m, 12 Feb 1983, (CSIRO stn B8), NMV J11248(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm axial, with strong step. Pereopod 2 carpus with roundly produced posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod exceeds telson, elongate, 2.2 times as long as wide, distally rounded. Exopod twice as long as wide, with a short distoventral lobe, dorsal margin evenly convex. Telson only moderately domed, tapering strongly to an acute apex, distolateral margins slightly concave, dorsal setae in pairs distally.

Male. Unknown.

Distribution. North-western Australia, shallow sedimentary habitats, 14-40 m.

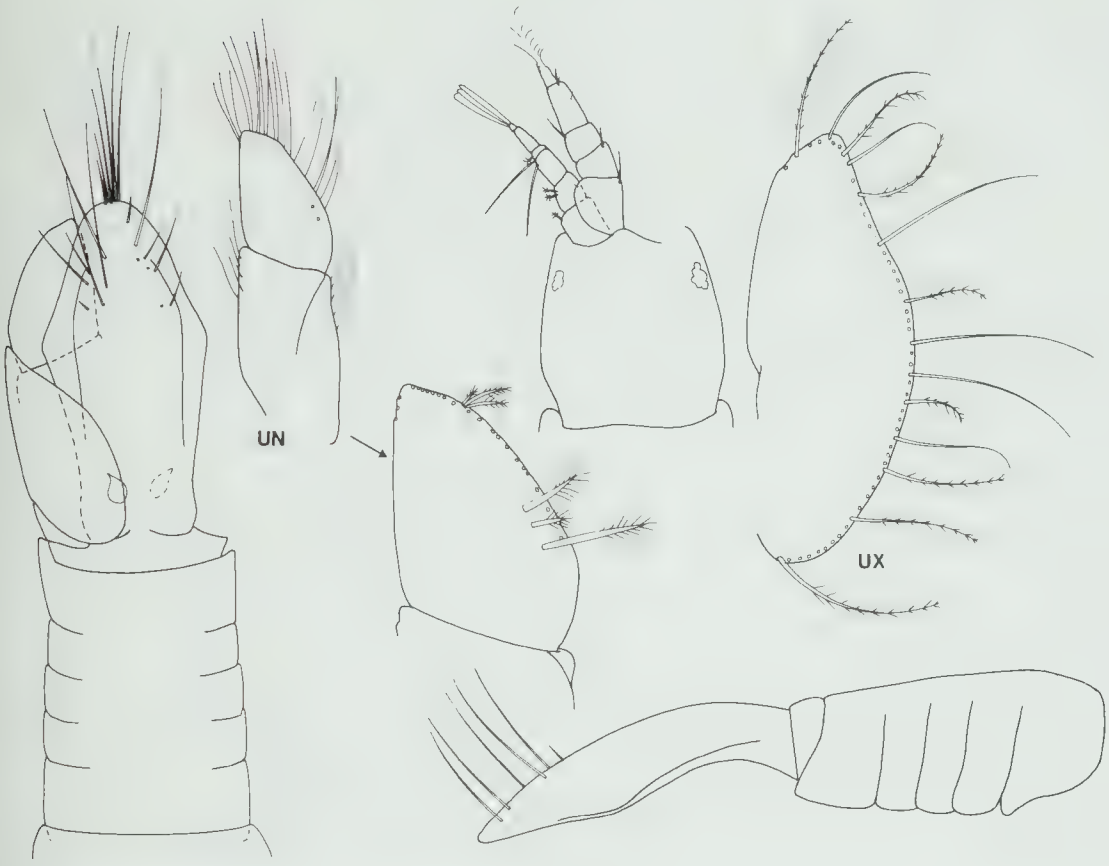

Figure 4. *Amakusanthura angophora.* Holotype juvenile.

Remarks. Miers (1884) recognised that his specimen was probably not the same as that described by Haswell (1881) and his error was corrected by Barnard. Until recently only the type specimen existed but the marine fauna of north-western Australia is little known. The species is characterised by its especially acute telson and elongate uropodal endopod.

Amakusanthura dodonaea sp. nov.

Figures 9, 10

Material examined. 3 submales, 21 juveniles; 3.2-9.2 mm.

Holotype. Juvenile, 5.5 mm, AM P36774. Qld, One Tree Is. (23°30′S, 152°05′E), central lagoon, 3 m, C. Short and J. Young, 17 Oct 1979.

Paratypes. Qld, Lizard Is. (14°40′S, 145°25′E), various localities and dates, to 15 m, AM P29644(2), P26645(1), P29646(1 + submale, 4.2 mm), P29647(1), P36775(1); NMV J12309(1), J12310(1).

Diagnosis. Rarely pigmented. Pereopod 1 propodus curved proximally and parallel to carpal suture distally, length twice greatest width; palm oblique, with strong convexity at midpoint. Pereopod 2 carpus with barely lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod as long as telson, elongate, almost twice as long as wide. Exopod 2.1 times as long as wide, with acute distoventral lobe, widest distally. Telson strongly domed anteriorly, thinner and upturned laterally and especially around distal margin, tapering to broadly rounded apex, with few dorsal long setae. Male. Only submale known. Antenna 1 flagellum of 13 articles, reaching to middle of pereonite 3. Head smaller, with broad rostrum and large eyes. Telson dished posteriorly.

Distribution. Great Barrier Reef islands, lagoon sediments.

Remarks. Amakusanthura dodonaea is best charac-

Figure 5. *Amakusanthura angophora*. Holotype juvenile.

terised by the upturned rim on the telson, a character shared with *A. brachyscome* (q.v.).

Amakusanthura eugenia sp. nov.

Figures 11, 12

Material examined. 2 males, 27 juveniles; 5.8-13.4 mm.

Holotype. Juvenile, 13.4 mm, NMV J12320. Qld, Bowling Green Bay (19°14′S, 147°07′E), coarse silt, P. Arnold, 17 Jun 1975 (TBS stn).

Paratypes. Qld, Bowling Green Bay and Halifax Bay (TBS stns), NMV J12321(1), J12322(1), J12324-J12326(3), J12330-J12332(3); AM P36776(2); QM W12168(1). NE of Townsville, NMV J12327-J12329(4), J12333(1).

Other material. Qld, Townsville bays (TBS stns), NMV J12323(1), J12343(submale, 11 mm), J12344(1), J12345(1). Triangular Is., Shoalwater Bay (22°23′S, 150°30′E), J. Lewis, 1981-1982, NMV J12334-J12339(6), J12340(male, 13 mm), J12341(1), J12342(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin almost straight and strongly produced distally; palm axial, long, with step at midpoint. Pereopod 2 carpus with produced

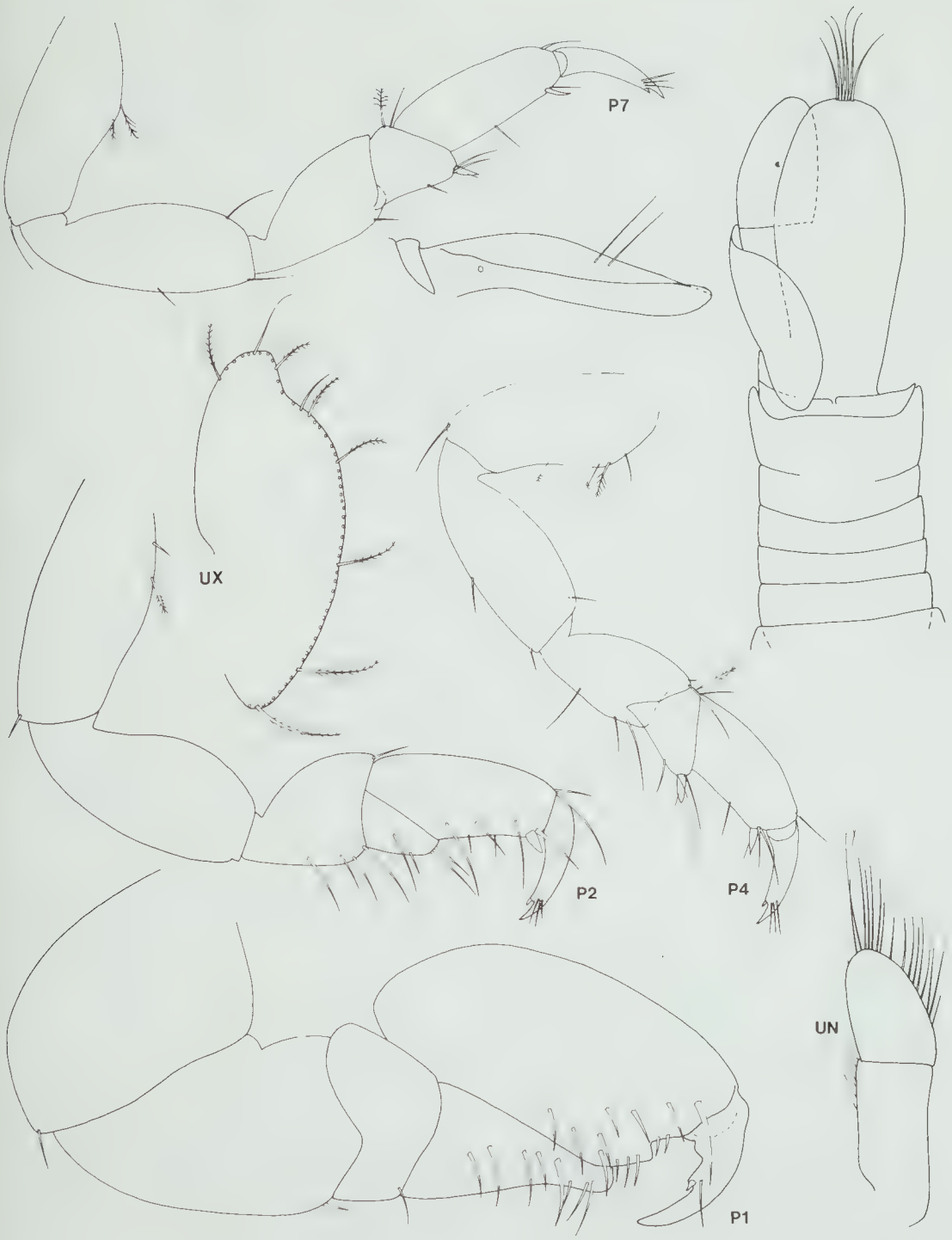

Figure 6. *Amakusanthura brachyscome*. Holotype juvenile.

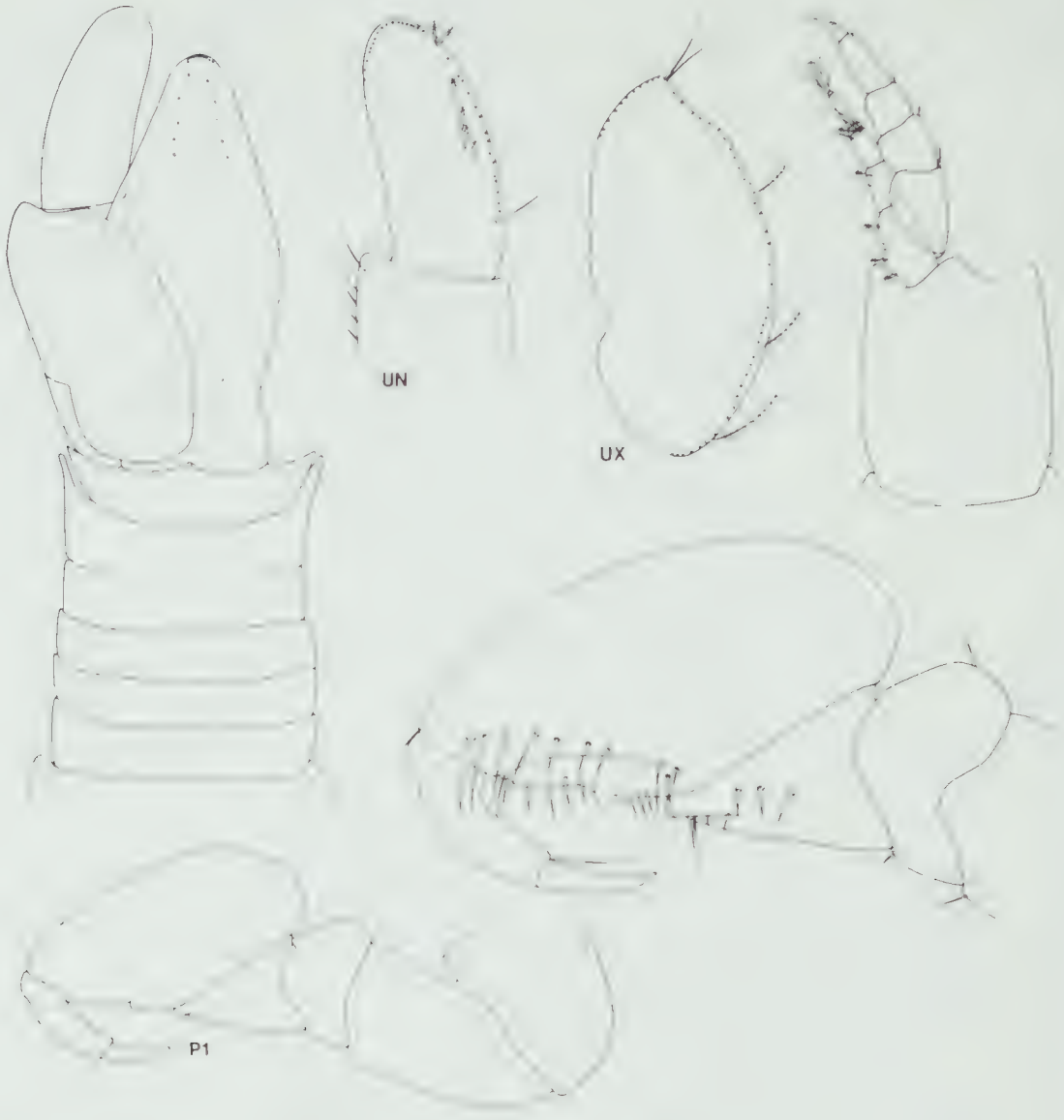

Figure 7. *Amakusanthura coppingeri.* Holotype juvenile.

posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod reaching to end of telson, triangular, almost twice as long as wide, apex and lateral margin evenly convex. Exopod twice as long as wide, with definite distoventral lobe, distal notch and convex dorsal margin. Telson dorsally flat, widest at midpoint and tapering to narrowly rounded apex, lateral margins evenly convex, with few dorsal setae. Male. Antenna 1 flagellum of 28 articles, reaching to end of pereonite 3. Head with small chin, large eyes and broad rostrum. Posterior pereopods more elongate than in juvenile, telson and uropods as in juvenile. With minute pair of penes.

Distribution. Central Queensland bays and shallow shelf; silty sediments.

Remarks. A very flat, simple telson and broad uro-

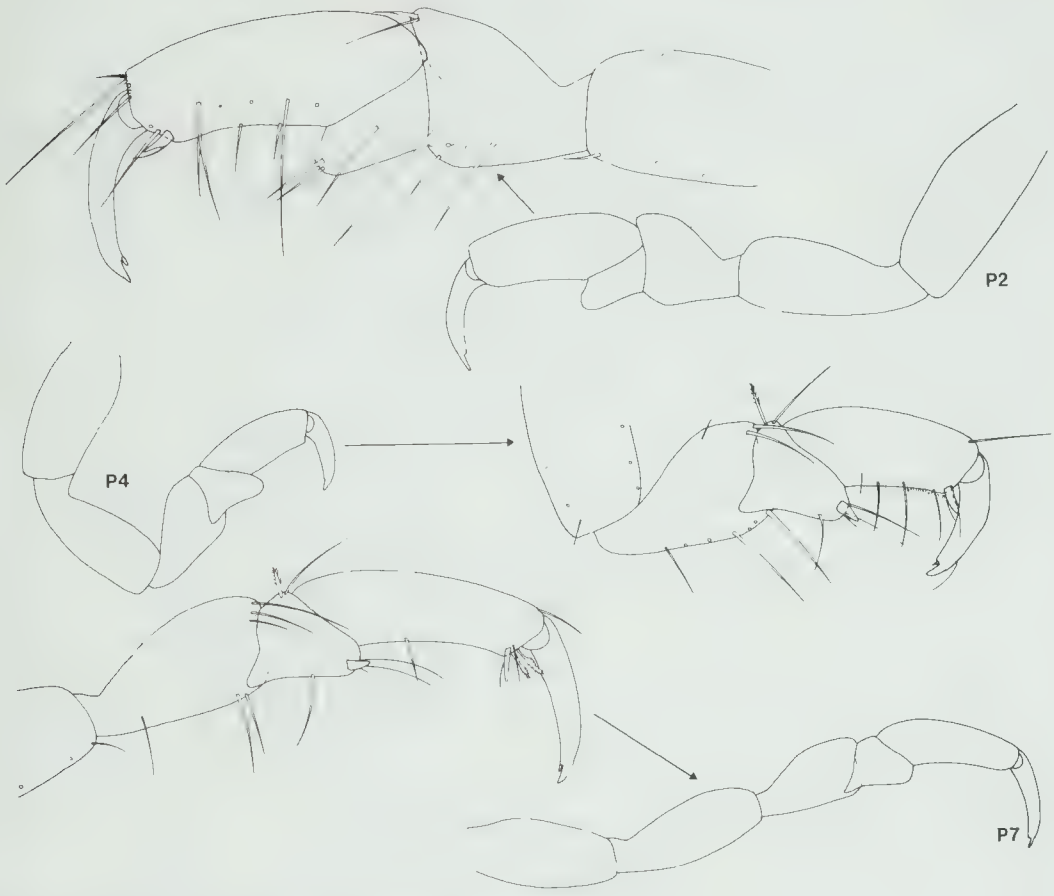

Figure 8. *Amakusanthura coppingeri.* Holotype juvenile.

podal exopod characterise this, one of the largest of all the tropical species of *Amakusanthura.*

Amakusanthura goodenia sp. nov.

Figures 13, 14

Material examined. 1 submale, 10 juveniles; 4.4-7.2 mm.

Holotype. Juvenile, 6.8 mm, NMV J12350. Qld, Cleveland Bay (19°11′S, 146°56′E), 10 m, very fine sand, P. Arnold, 8 Oct 1975 (TBS stn).

Paratypes. Qld, Bowling Green Bay, Cleveland Bay and Halifax Bay, 3-10 m (TBS stns), NMV J12346-J12349(4), J12351(1), J12354(1), J12355(submale, 7.2 mm), J12356(1).

Diagnosis. Not pigmented. Pereopod 1 anterior margin gently curved, length twice greatest width; palm axial but abruptly stepped from carpus, with strong distal tooth. Pereopod 2 carpus with roundly lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod reaching well beyond telson, elongate, 1.8 times as long as wide, distolateral margin continuously convex. Exopod twice as long as wide, with an acute distoventral lobe separated from dorsal lobe by a shallow notch. Telson moderately domed, tapering abruptly beyond midpoint to a narrower apex, with few dorsal setae. Male. Only submale known. Antenna 1 flagellum of 15 articles reaching to midway along pereonite 3.

Distribution. Central Queensland bays, 3-10 m, fine sandy sediments.

Remarks. The distally narrowed telson distinguishes *Amakusanthura goodenia* from the others with which it co-occurs. A similar species with a narrowed telson, *A. wahlenbergia,* occurs in reef lagoonal environments but is separated by its smaller size, more elongate uropodal endopod,

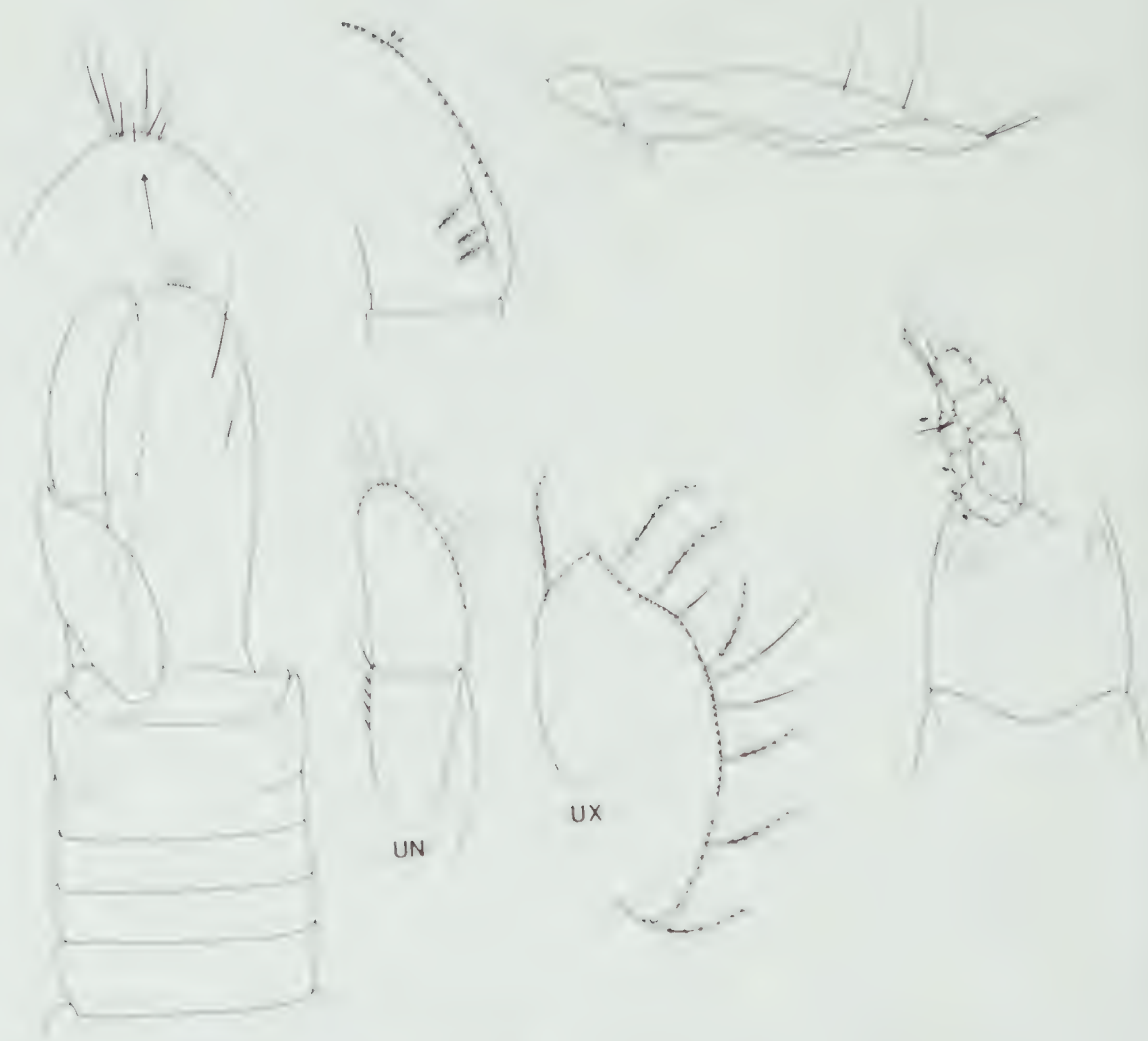

Figure 9. *Amakusanthura dodonaea*. Holotypejuvenile.

more acute telson and more rectangular propodi of pereopods 4-7.

Amakusanthura hibbertia sp. nov.

Figures 15-17

Material examined. 2 submales, 62 juveniles; 5.3-15.2 mm.

Holotype. Juvenile, 11.1 mm, AM P29730(with slide). Qld, Lizard Is. (14°40′S, 145°28′E), lagoon at south end of island, 4 m, A. Jones and C. Short, 11 Oct 1978.

Paratypes. Qld, Lizard Is., various localities: AM P29633(3), P29634(submale, 8.5 mm), P29635(2), P29636(3), P29639-P29641(4), P29643(3), P29649(1), P29650(1), P29666(23), P29696(1), P29698(1), P29699(1), P29731-P29733(3), P29737(1), P29739(1), P29990(1), P36777(2); QM W12169(1); NMV J12357-J12361(5).

Other material. Qld, One Tree Is. (23°30′S, 152°05′E), C. Short and J. Young, Oct 1979, AM P29692(1), P29779(submale, 15.2 mm).

WA, North-west Shelf, 20°00′S, 117°00′E, 52 m, 4 Sep 1983 (CSIRO stn B17), NMV J12262(2); 19°57′S, 117°54′E, 43 m, 26 Aug 1983 (CSIRO stn B2), NMV J12363(1).

Diagnosis. Dorsally pigmented brown. Pereopod 1 carpus anterior margin gently curved, length 2.1 times greatest width; palm stepped away from carpus, more or less axial, with a strong proximal tooth. Pereopod 2 carpus with strongly and broadly lobed posterdistal margin. Pereopods 2-7 all with broad setose distal articles. Pleonites 1-4 separated

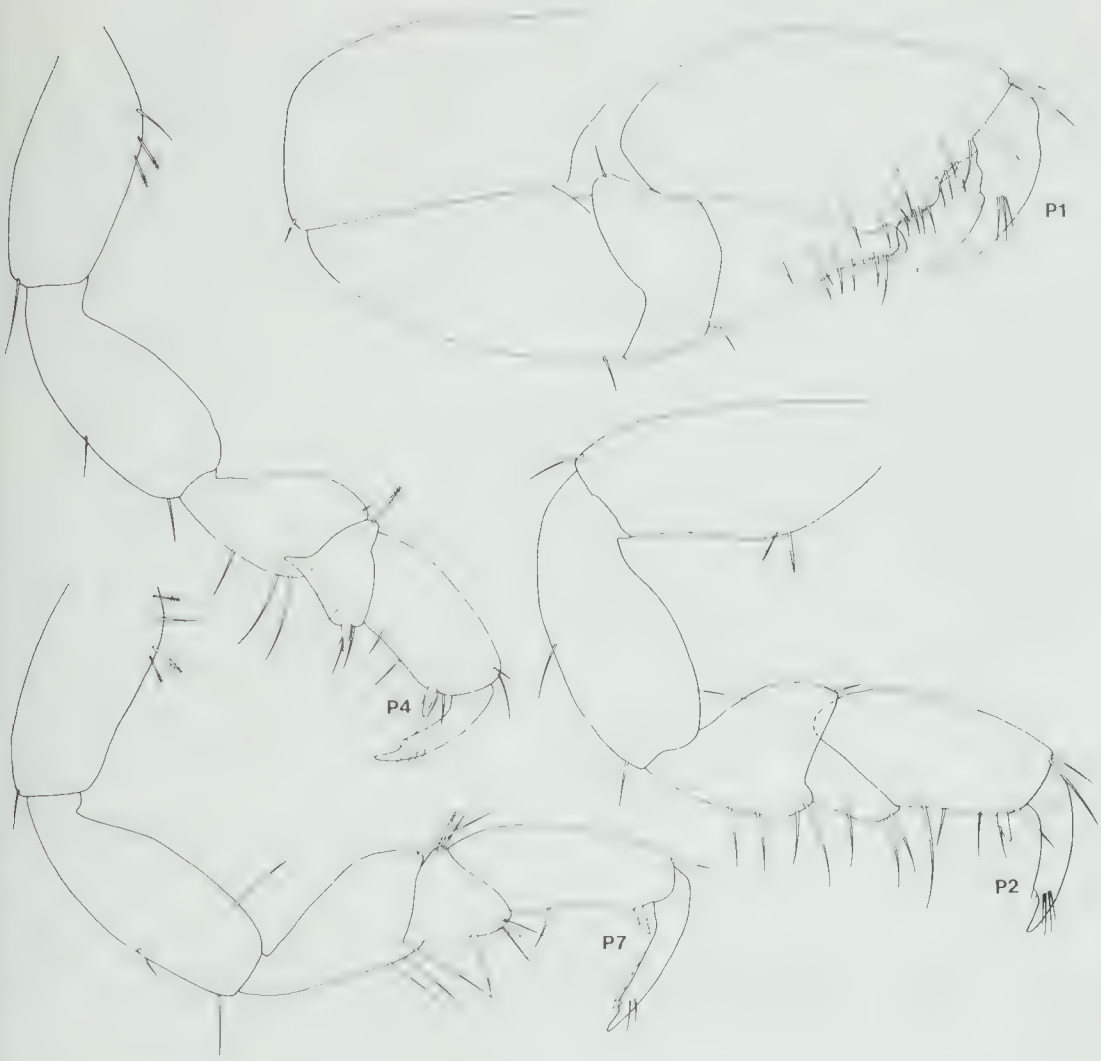

Figure 10. *Amakusanthura dodonaea*. Holotype juvenile.

by dorsal grooves. Uropodal endopod barely exceeding telson, triangular, 1.6 times as long as wide, distolateral margin evenly convex. Exopod 2.2 times as long as wide, with prominent acute distoventral lobe separated from dorsal lobe by a strong notch. Telson strongly and broadly domed, tapering to a broadly rounded apex, with 3 pairs of setae.

Male. Submale only known. Antenna 1 flagellum of 30 articles reaching to posterior margin of pereonite 2. Telson with a mid-dorsal depression. Pereopods more elongate and less setose than in juvenile.

Distribution. Great Barrier Reef island lagoonal sediments; North-west Shelf, 43-52 m.

Remarks. In many ways *Amakusanthura hibbertia* resembles some species of *Apanthura*, especially those of species-group 2 (Poore and Lew Ton, 1985). This is the only *Amakusanthura* with lobed and richly setose pereopods but the pleonal dorsal grooves and long male antennal flagellum confirm its generic placement. The long antennal setae are also a feature of the species. The species is one of the largest from reef lagoonal habitats and can be distinguished from *A. pandorea* by the pereopodal setae and strongly domed telson.

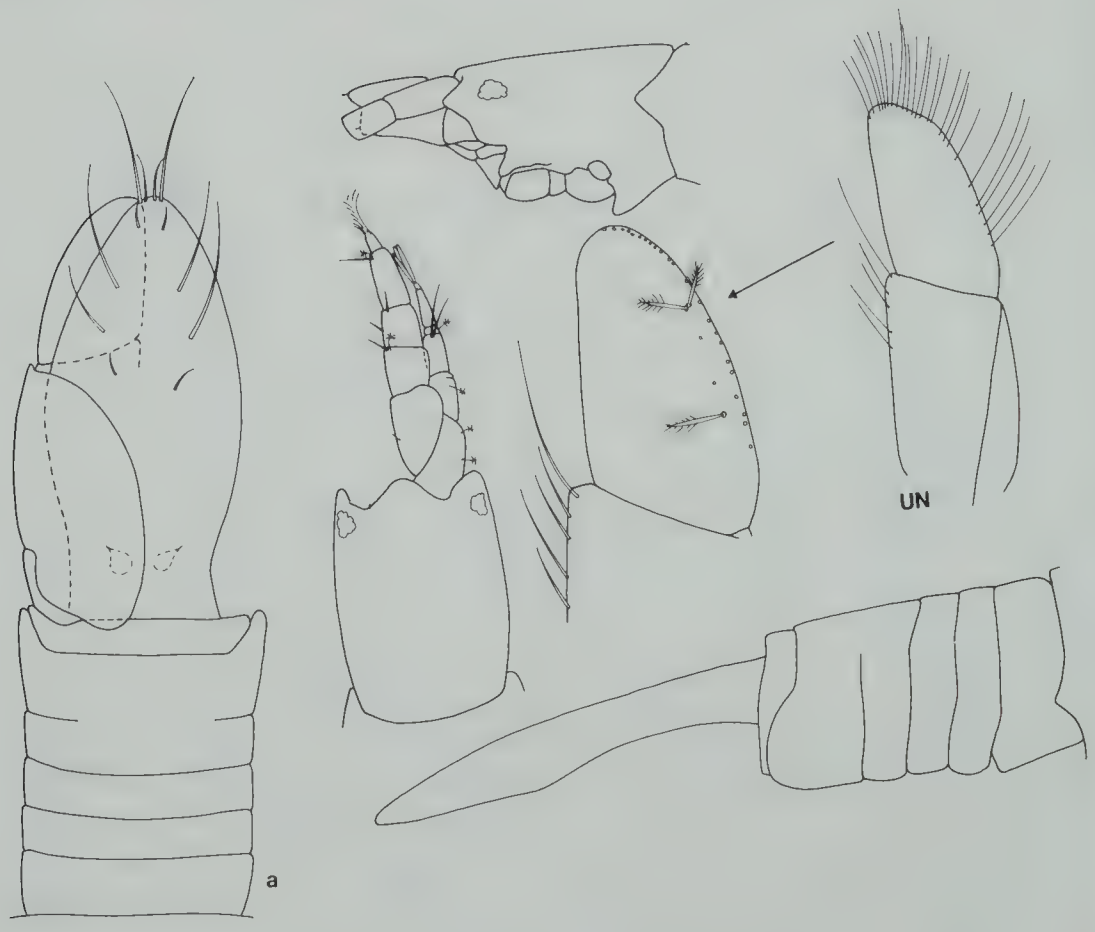

Figure 11. *Amakusanthura eugenia.* Holotype juvenile; a, paratype juvenile, 9.4 mm, NMV J12329.

The specimens from the North-west Shelf differ from those from north-eastern Australia in having a more acutely tapering telson a more definitely notched uropodal exopod.

Amakusanthura kingia sp. nov.

Figures 18, 19

Material examined. 2 males, 14 juveniles; 4.4-6.9 mm.

Holotype. Juvenile, 5.9 mm, NMV J12369. Qld, Townsville bays area (19°S, 147°E), P. Arnold, 1974-1977 (TBS stn).

Paratypes. Qld, NE of Townsville, various localities, 23-24 m, muddy sand, G.C.B. Poore and H.M. Lew Ton, 24 Nov 1982, NMV J12370(2), J12371(3), J12379(1). Triangular Is., Shoalwater Bay (22°23′S, 150°31′E), various localities, intertidal mudflats, J. Lewis, 1978-1982, NMV J12372-J12381(7 + 2 males, 5.7 mm).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm axial, slightly convex, without tooth. Pereopod 2 carpus with roundly angled posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod as long as telson, elongate, curved, almost twice as long as wide, lateral margin without setae along the middle of its length. Exopod 2.4 times as long as wide, distoventral lobe broad, dorsal margin sinuous. Telson slightly domed, tapering most strongly in distal third, apically thin and slightly upturned, with irregularly arranged dorsal setae.

Male. Antenna 1 flagellum of 13 articles reaching to end of pereonite 2. Pleon elongated, uropodal endopod elongated beyond telson. Telson with a mid-dorsal depression.

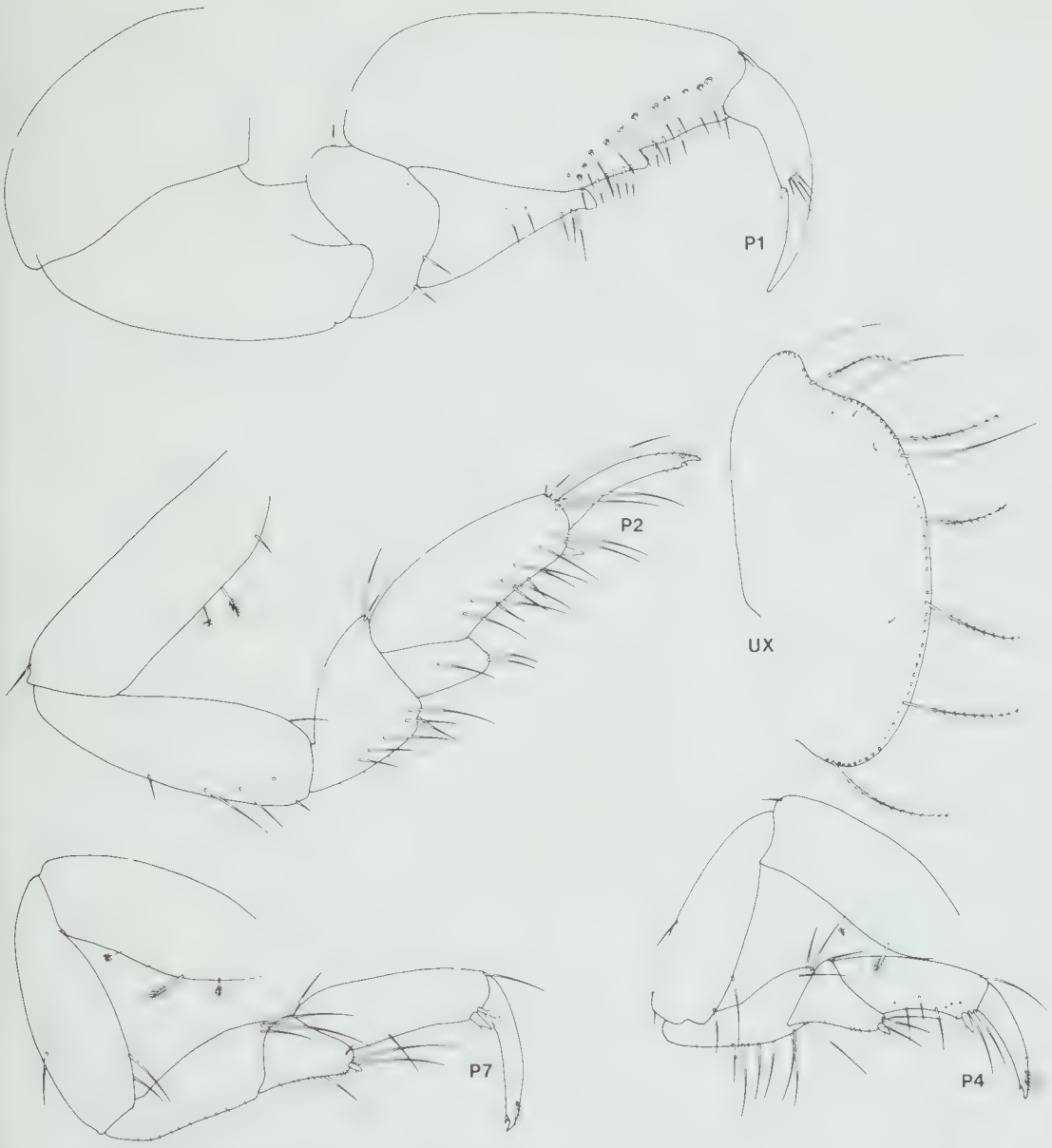

Figure 12. *Amakusanthura eugenia.* Holotype juvenile.

Distribution. Central Queensland, bays and shelf, sedimentary environments, intertidal-24 m.

Remarks. Amakusanthura kingia is a small species best recognised by its narrow uropodal exopod and the gap in the setal row on the endopod.

Amakusanthura lechenaultia sp. nov.

Figures 20, 21

Material examined. 3 juveniles; 4.3-8.7 mm.

Holotype. Juvenile, 8.7 mm, NMV J12380. Qld, Bowling Green Bay (19°18′S, 147°07′E), coarse silt, P. Arnold, 13 Mar 1975 (TBS stn).

Figure 13. *Amakasanthura goodenia*. Holotype juvenile.

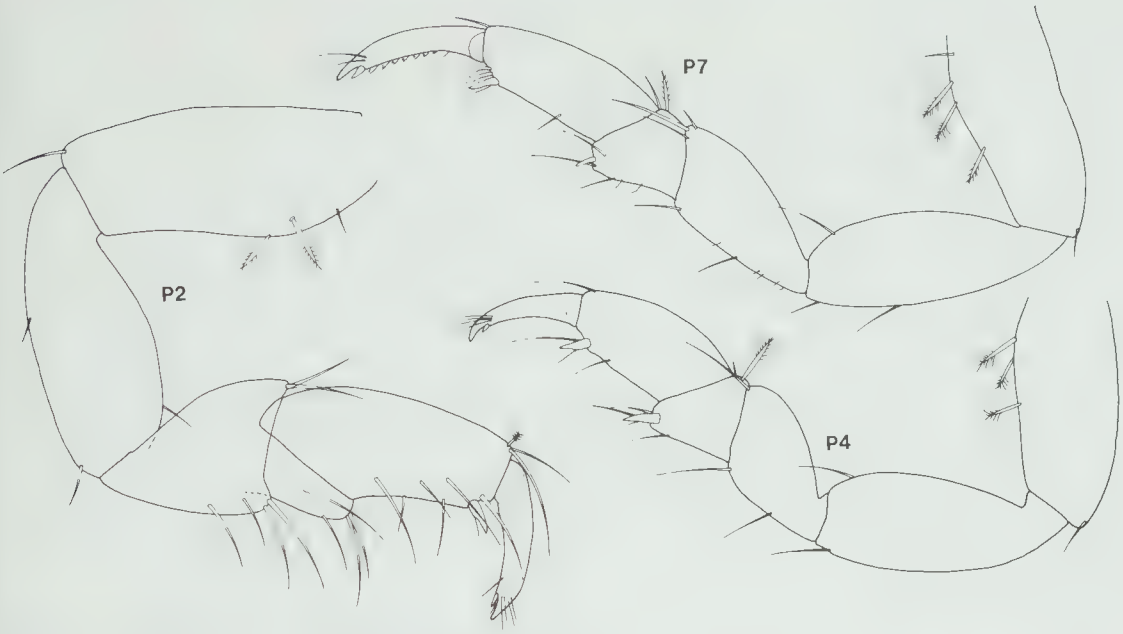

Figure 14. *Amakusanthura goodenia.* Holotype juvenile.

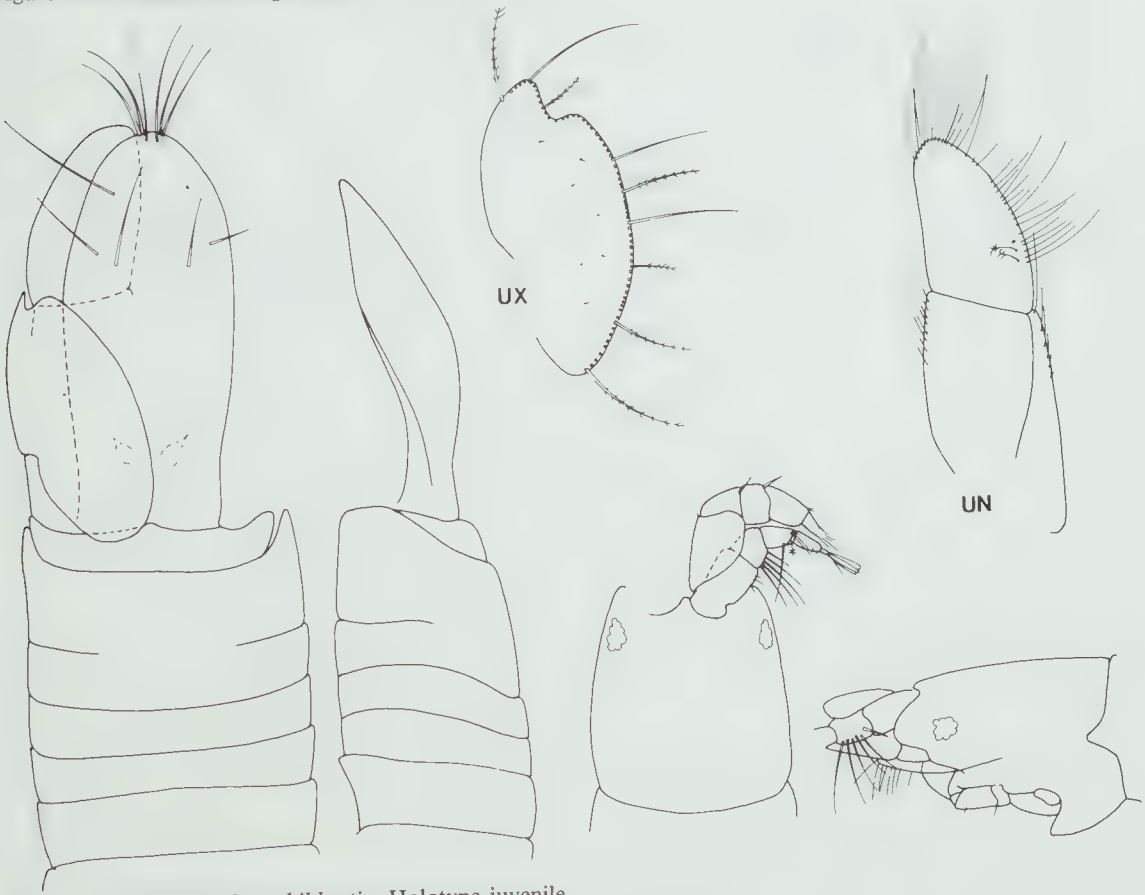

Figure 15. *Amakusanthura hibbertia.* Holotype juvenile.

Figure 16. *Amakusanthura hibbertia*. Holotype juvenile; a, paratype submale, 8.5 mm, AM P29639.

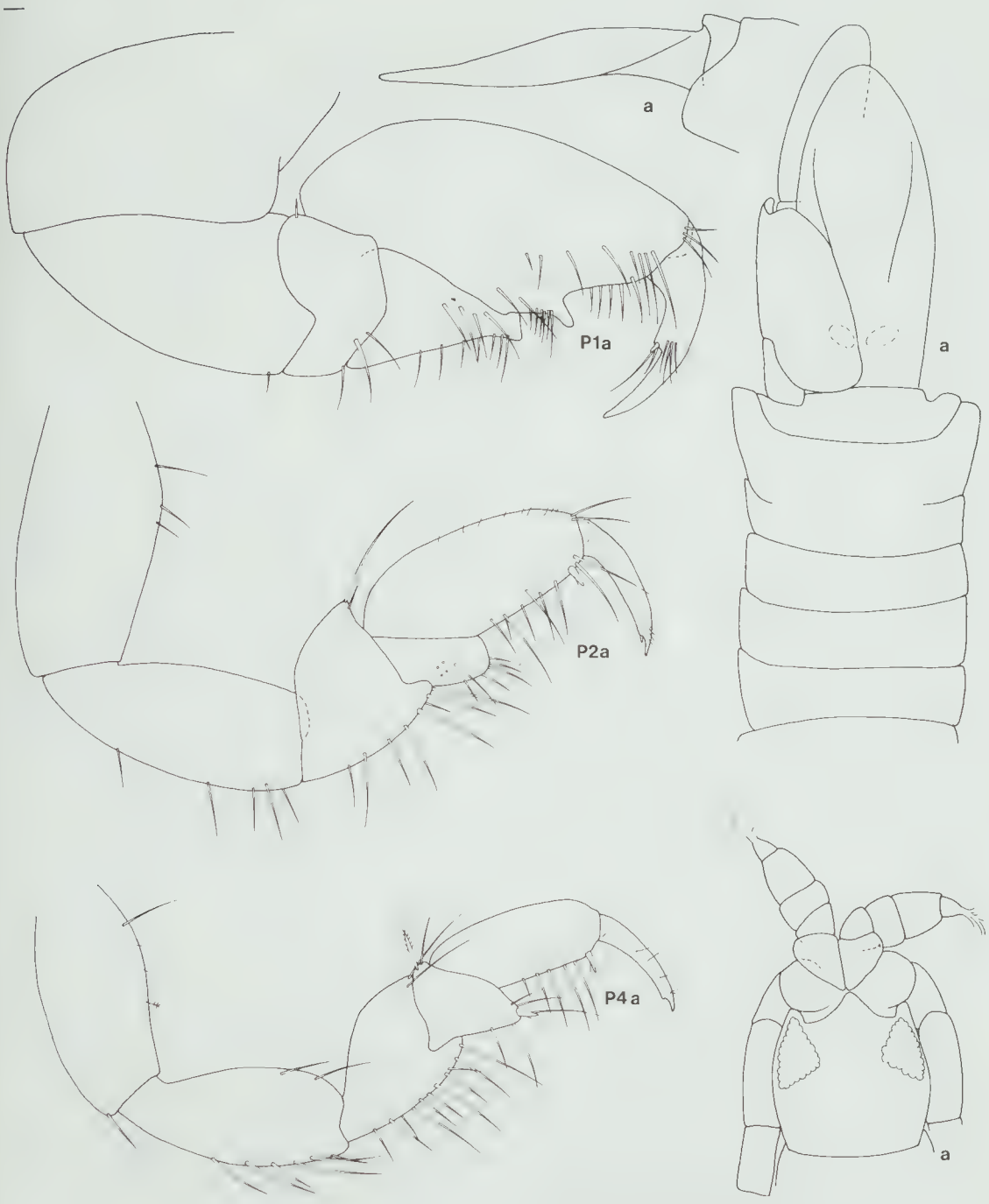

Figure 17. *Amakusanthura hibbertia.* a, paratype submale, 8.5 mm, AM P29639.

Figure 18. *Amakusanthura kingia.* Holotype juvenile.

Figure 19. *Amakusanthura kingia.* Holotype juvenile.

Paratypes. Qld, Halifax Bay (TBS stns), NMV J12381(1), J12382(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin straight over most of its length and parallel to carpal suture; palm axial but stepped from carpus, with a concavity at the mid-point, without tooth. Pereopod 2 carpus with slightly lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod not reaching end of telson, elongate, twice as long as wide, lateral margin convex. Exopod 2.4 times as long as wide, with acute distoventral lobe, shallow dorsal notch and convex dorsal margin. Telson moderately domed anteriorly, especially elongate, evenly curved lateral margins tapering to acute apex, with few dorsal setae.

Male. Unknown.

Distribution. Central Queensland bays; sedimentary environments.

Remarks. These three individuals could not be reconciled with any of the other species from the area and, because of their especially elongate telson, represent a separate species. The species is most similar to *A. correa* (Poore and Lew Ton) from Moreton Bay, southern Queensland from which it differs in more elongate telson and uropodal exopods.

Amakusanthura melaleuca sp. nov.

Figure 22

Material examined. 5 juveniles; 4.0-7.6 mm.

Holotype. Juvenile, 7.6 mm, NMV J12383. Qld, Halifax Bay (19°05'S, 146°48'E), 12 m, very fine sand, P. Arnold, 26 Feb 1976 (TBS stn).

Paratypes. Qld, Bowling Green Bay and Halifax Bay (TBS stns), NMV J12384(1), J12385(1), J12387(1).

Other material. Qld, Triangular Is., Shoalwater Bay, intertidal mudflat, NMV J12386(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm oblique, with a blunt step at midpoint. Pereopod 2 carpus with roundly lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod exceeding telson by almost one-third its length, elongate, twice as long as wide, lateral margin only weakly convex, apex acutely rounded. Exopod 1.8 times as long as wide, with acute distoventral lobe separated from broad dorsal lobe by angled notch. Telson slightly domed, tapering to truncate apex, lateral margins thin, convex, with few dorsal setae.

Male. Unknown.

Distribution. Central Queensland, bays, intertidal—shallow subtidal sediments.

Remarks. Amakusanthura melaleuca differs from all other species in the possession of especially elongate uropodal endopods well exceeding the telson. It is most similar to *A. pimelia* (Poore and Lew Ton) from Moreton Bay and northern New South Wales.

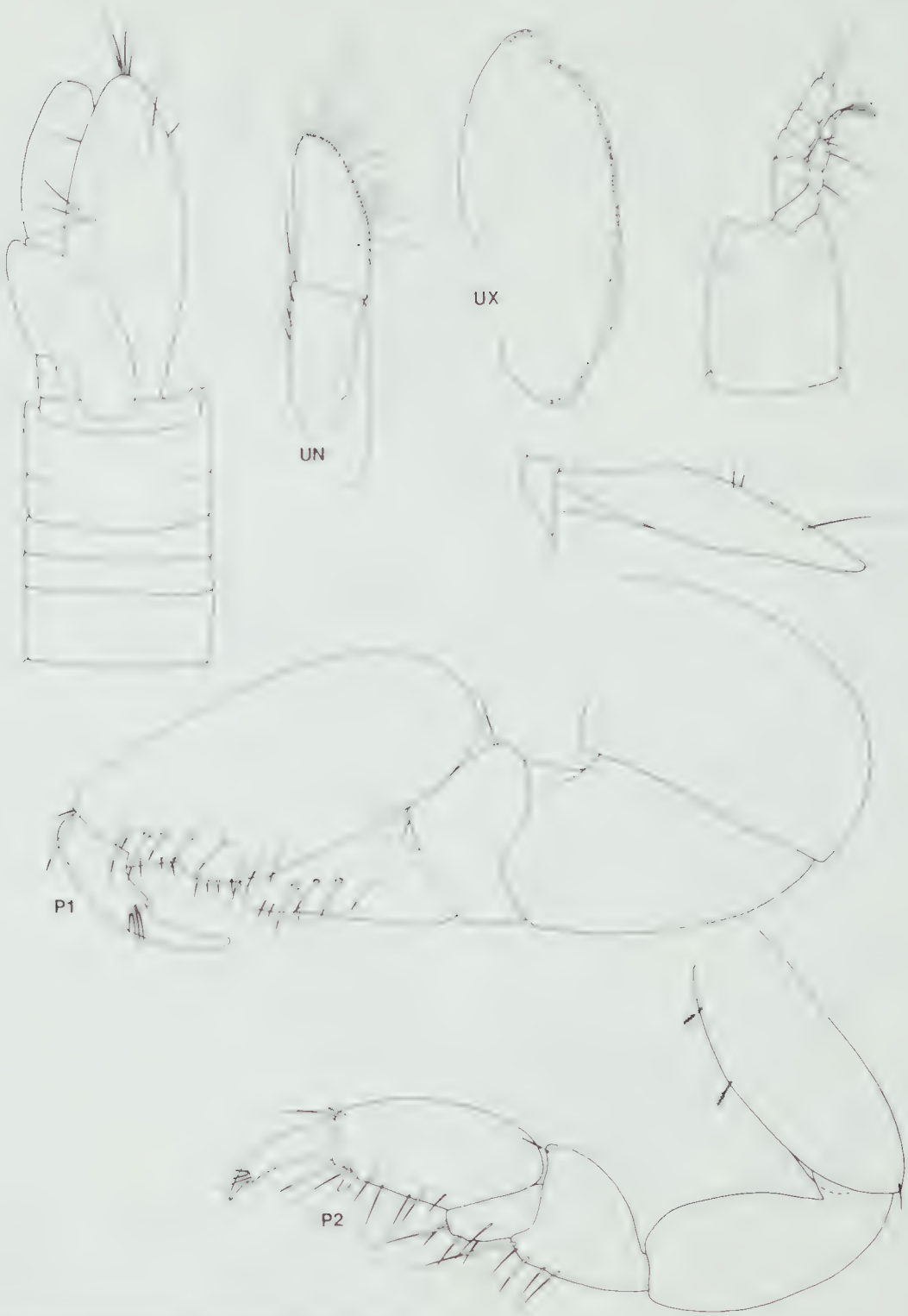

Figure 20. *Amakusanthura lechenaultia*. Holotype juvenile.

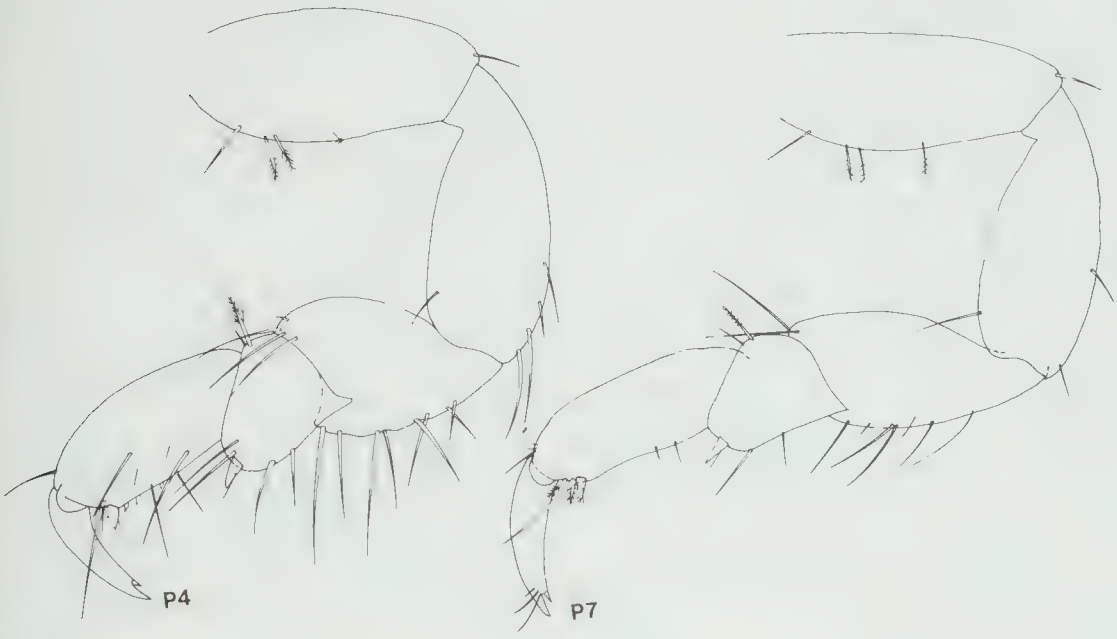

Figure 21. *Amakusanthura lechenaultia.* Holotype juvenile.

Amakusanthura pandorea sp. nov.

Figures 23, 24

Material examined. 5 juveniles; to 14.0 mm.

Holotype. Juvenile, 14.0 mm, NMV J12388. Qld, Halifax Bay (19°05′S, 146°45E), 12 m, very fine sand, P. Arnold, 26 Feb 1976.

Paratypes. Qld, type locality, NMV J12390(2). Townsville bays (TBS stns), NMV J12389(1), J12391(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin gently curved, length twice greatest width; palm axial and stepped away from carpus, long, with strong step at midpoint. Pereopod 2 carpus with angled posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod reaching as far as telson, triangular, little longer than wide, lateral margin and apex continuously convex. Exopod twice as long as wide, distoventral lobe rounded, separated from convex dorsal lobe by shallow notch. Telson only slightly domed, distal third tapering to broad apex, distolateral margins straight, with numerous dorsal setae distally.

Male. Unknown.

Distribution. Central Queensland, bays, shallow subtidal sediments.

Remarks. Amakusanthura pandorea differs from *A. agonis,* another large species from the Townsville region, in its flattened telson and pleonal grooves. The species may key with *A. hibbertia* but lacks the dense pereopodal setae of this species.

Amakusanthura tristania sp. nov.

Figures 25, 26

Material examined. 1 submale, 28 juveniles; 2.6-6.2 mm.

Holotype. Juvenile, 6.2 mm, AM P29803(with slide). Qld, Lizard Is. (14°40′S, 145°28′E), eastern end of Mangrove Beach, 2 m, sand, A. Jones, 10 Oct 1978.

Paratypes. Qld, Lizard Is., various localities: AM P29637(1), P29638(1), P29642(2), P29648(1), P29661(1), P29662(1), P29671(1), P29697(1), P29700(1), P29729(1), P29738(1), P29741(1), P29800(1), P29989(1), P36778(2 + submale, 4.5 mm); QM W12170(6); NMV J12401-2(2), J12404(1). Britomart Reef (18°17′S, 146°38′E), NMV J12402(1).

Diagnosis. Not pigmented. Pereopod 1 propodus anterior margin strongly curved, length twice greatest width; palm short, oblique, stepped away

Figure 22. *Amakusanthura melaleuca*. Holotype juvenile.

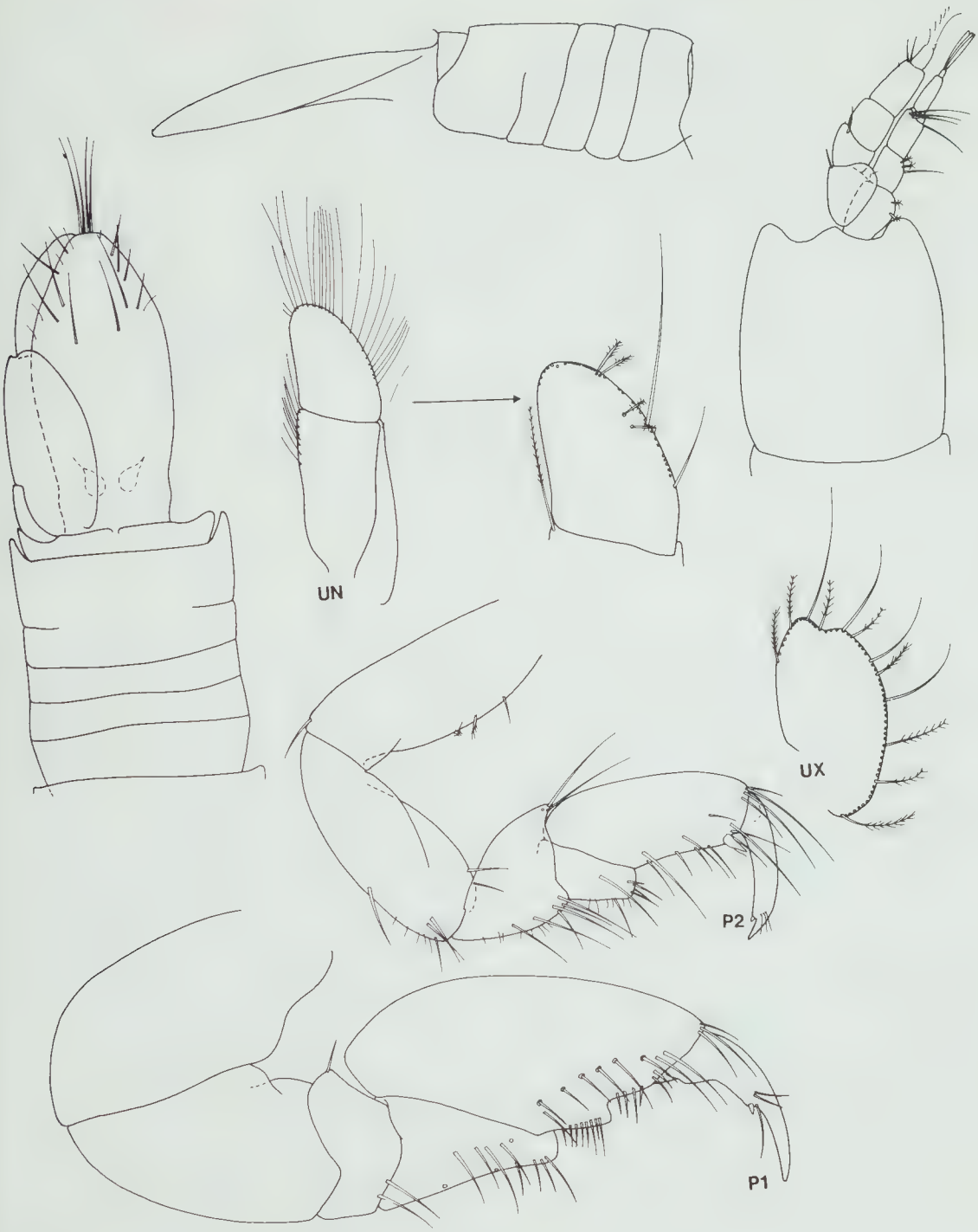

Figure 23. *Amakusanthura pandorea.* Holotype juvenile.

Figure 24. *Amakusanthura pandorea*. Holotype juvenile.

from carpus, with blunt tooth at midpoint. Pereopod 2 carpus with bluntly lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod exceeding telson slightly, subtriangular, 1.8 times as long as wide, lateral margin convex. Exopod 2.1 times as long as wide, distoventral lobe broad, dorsal margin evenly convex. Telson slightly domed, almost parallel-sided proximally and tapering only gradually to broad apex, with few dorsal setae.

Male. Submale only known. Antenna 1 flagellum of 14 articles, reaching to end of pereonite 2.

Distribution. North and central Great Barrier Reef, lagoonal sediments.

Remarks. Amakusantura tristania is a small species characterised by a broadly rounded telson and broad uropodal exopod. The existence of a very small male with these features confirms that these specimens are not juveniles of another reef species.

Amakusanthura wahlenbergia sp. nov.

Figures 27, 28

Material examined. 1 submale, 10 juveniles; 3.6-6.9 mm.

Holotype. Juvenile, 6.9 mm, AM P29678(with slide). Qld, Lizard Is. (14°40′S, 145°28′E), 100 m off Chinamans Ridge, Mrs Watsons Bay, 9 m, A. Jones and C. Short, 13 Oct 1978.

Paratypes. Qld, Lizard Is., various localities: AM P29652(1), P29665(1), P29673(2), P29675(1), P29677(1), P29679(1), P29680(1), P29683(1), P29694(1 submale, 6.3 mm).

Diagnosis. Not pigmented. Pereopod 1 propodus broadening distally, length 2.3 times greatest width; palm axial, stepped away from carpus, with blunt tooth. Pereopod 2 carpus with barely lobed posterodistal margin. Pleonites 1-4 separated by dorsal grooves. Uropodal endopod just exceeding telson, elongate, twice as long as wide, apex broadly rounded. Exopod twice as long as wide, distoventral lobe acute, small, separated by notch from extensive convex dorsal lobe. Telson only slightly domed, distinct lateral flanges proximal to concave distolateral margins, apex acute, with few dorsal setae.

Male. Submale only known. Antenna 1 flagellum of 19 articles reaching as far as middle of pereonite 3.

Distribution. Northern Great Barrier Reef, lagoonal sediments.

Remarks. The distinctive lateral flanges and acute apex on the telson of *Amakusanthura wahlenbergia* distinguish it from other reef species. Its small size, particularly of the male, and narrower uropodal endopod differentiate the species from *A. goodenia* which has a similar telson but comes from shelf habitats.

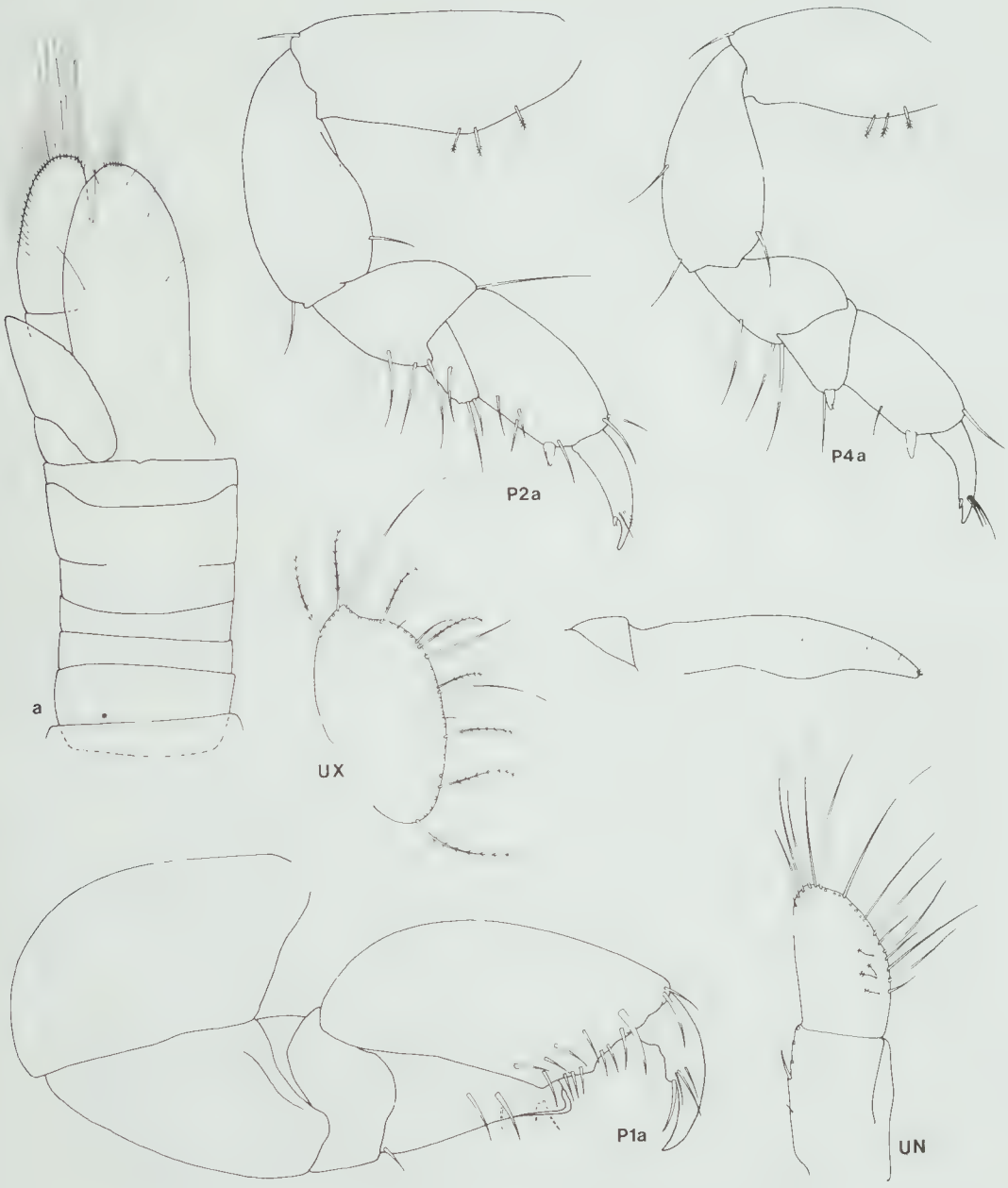

Figure 25. *Amakusanthura tristania.* Holotype juvenile.

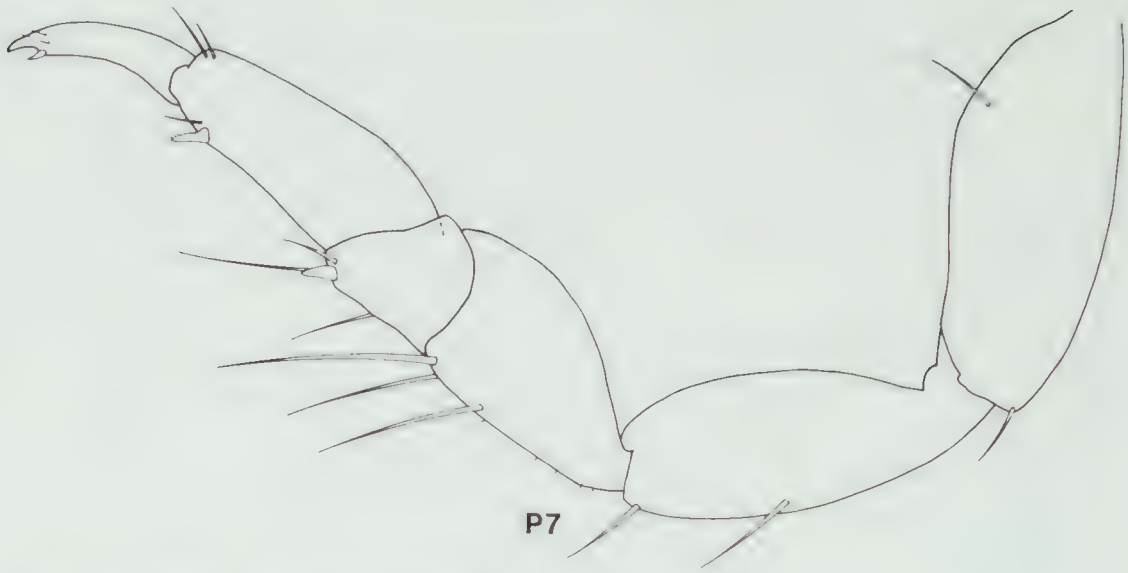

Figure 26. *Amakusanthura tristania*. Holotype juvenile.

Apanthura Stebbing

Remarks. Apanthura was recently diagnosed by us and differentiated from *Apanthuretta* (= *Amakusanthura*) (Poore and Lew Ton, 1985). The most reliable character differentiating it from *Amakusanthura* is the much shorter male antenna 1 flagellum (fewer than 10 articles) but the absence of grooves between pleonites is also useful. Males of *Apanthura* are far more modified than those of *Amakusanthura*, especially in the anterior pereopods.

In 1985 we divided the nine south-eastern Australian species of *Apanthura* into two species-groups. The tropical species described here cannot all be clearly assigned and may represent new groupings. *Apanthura restio* and *A. stipa* are small pigmented species whose males have only slightly modified limbs, differing in many ways from species from temperate environments. *Apanthura pultenaea* has attributes of both the groups already recognised but males are unknown.

Apanthura kennedia sp. nov.

Figures 29, 30

Material examined. 11 juveniles; 2.0-6.6 mm.

Holotype. Juvenile, 6.6. mm, AM P29801. Qld, Lizard Is. (14°40′S, 145°28′E), fringing reef between Bird Islet and South Is., coral rubble from reef base, 21 m, A. Jones, 7 Oct 1978.

Paratypes. Qld, NE of Townsville, muddy sand, G.C.B. Poore and H.M. Lew Ton, 24 Nov 1982: 19°03′S, 146°52′E, 23 m, NMV J12364(1); 18°24′S, 146°39′E, 45 m, NMV J12365(1). One Tree Is. (23°30′S, 152°05′E), various localities: AM P29676(1), P29780(1), P29781(1), P29782(2).

Other material. Qld, Townsville bays (TBS stns), NMV J12366-J12368(3).

Diagnosis. Not pigmented. Antenna 1 peduncle with 1 seta each on articles 2 and 3. Pereopod 1 carpus with blunt tooth; propodus palm nearly axial, with strong step, with about 7 mesial setae. Pereopod 2 merus without posterior lobe; carpus with subacutely lobed posterodistal margin; propodus rectangular. Pereopods 4-7 with only few posterior setae on merus and carpus. Uropod exceeding apex of telson; endopod with continuous row of setae along lateral and distal margin, twice as long as greatest width. Exopod 1.5 times as long as greatest width, ventrodistal lobe and apex of dorsal lobe equal, separated by a deep notch. Telson 1.5 times as long as pleon, 2.2 times as long as greatest width, lateral margins evenly convex, apex roundly acute, flat, 2 pairs of dorsal setae at distal third.

Male. Unknown.

Distribution. Great Barrier Reef islands and central Queensland bays, sedimentary habitats.

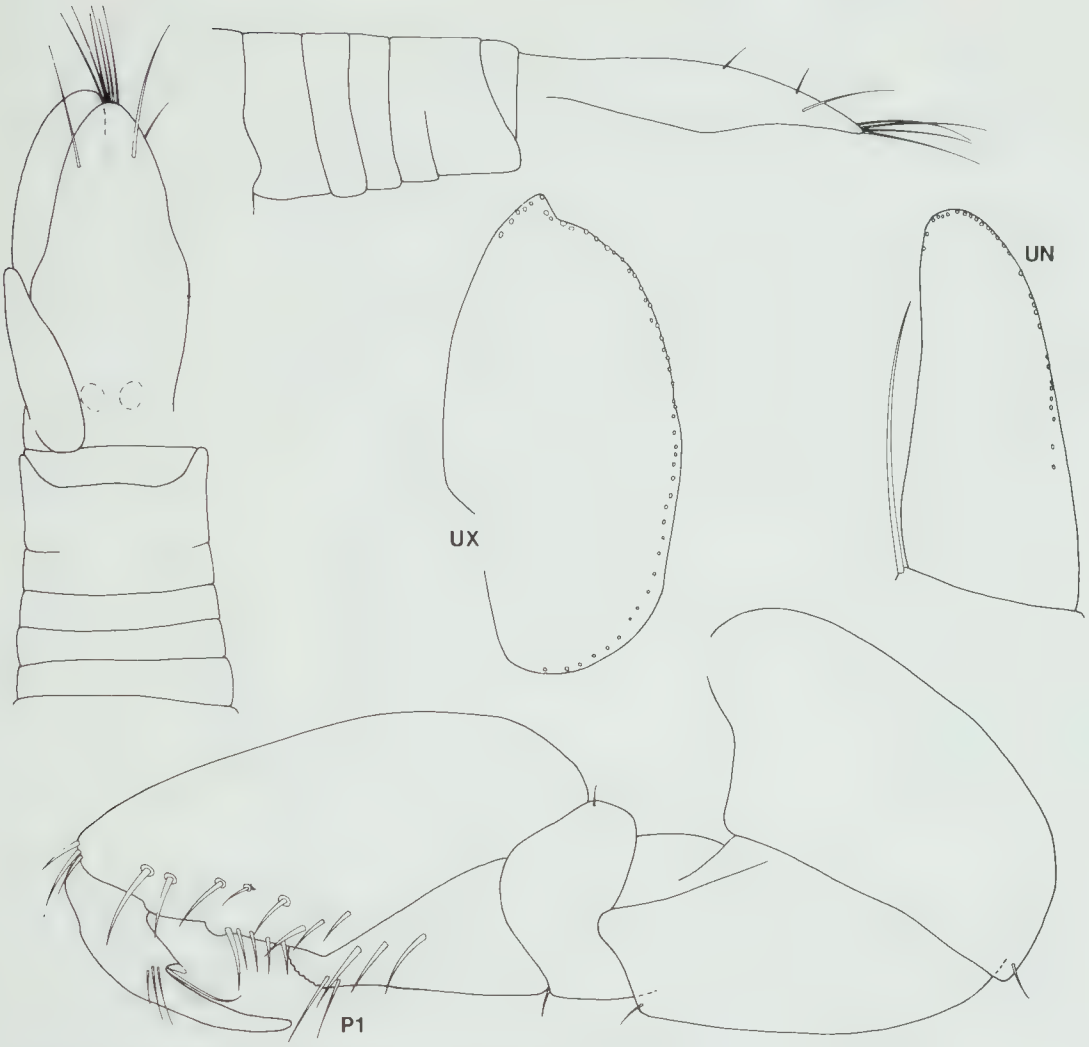

Figure 27. *Amakusanthura wahlenbergia.* Holotype juvenile.

Remarks. Apanthura kennedia is the only tropical species which can easily assigned to one of the two *Apanthura* species-groups (Poore and Lew Ton, 1985). It closely resembles *A. drosera* Poore and Lew Ton from deep sediments in Bass Strait. Both belong to *Apanthura* species-group 1. The new species may be separated on the basis of its more elongate telson, different uropodal exopod and shorter pereopod 1 palm.

In the material from Townsville bays the palm of pereopod 1 is more elongated than typical and bears a prominent tooth.

Apanthura pultenaea sp. nov.

Figures 31, 32

Material examined. 10 juveniles; 4.4-7.7 mm.

Holotype. Juvenile, 7.4 mm, NMV J12392(with slide) Qld, Halifax Bay (19°01′S, 146°34′E), 11 m, coarse silt, P. Arnold, 23 Nov 1976 (TBS stn).

Paratypes. Qld, Townsville bays (TBS stns), NMV J12393(1), J12397(1). NE of Townsville, muddy sand, 24-34 m , G.C.B. Poore and H.M. Lew Ton, 24 Nov 1982, NMV J12394(2), J12395(1), J12396(1).

Other material. WA, North-west Shelf (20°20′S, 115°58′E), 42 m, G.C.B. Poore and H.M. Lew Ton, 9

Figure 28. *Amakusanthura wahlenbergia*. Holotype juvenile.

Jun 1983, NMV J12398(1); 19°05'S, 118°58'E, 82 m, 23 Oct 83 (CSIRO stn B10), NMV J12399(1); 19°29'S, 118°52'E, 39 m, 25 Oct 1983 (CSIRO stn D3), NMV J12400(1).

Diagnosis. Not pigmented. Antenna 1 peduncle with 2-4 long lateral setae on articles 1 and 2. Pereopod 1 carpus with acute tooth; propodus palm axial, with strong tooth, with about 10 mesial setae. Pereopod 2 merus with slight posterior lobe; carpus with roundly lobed posterdistal margin; propodus rectangular. Pereopods 4-7 only moderately setose on articles 4 and 5. Uropod exceeding apex of telson; endopod with more or less continuous row of setae along distolateral margin, twice as long as greatest width. Exopod 1.7 times as long as wide, ventrodistal lobe acute, separated by distinct notch from broad dorsal lobe. Telson 1.2 times as long as pleon, twice as long as greatest width, lateral margins strongly convex at midpoint, tapering to an acute apex, flat, with few setae on distal third.

Male. Unknown.

Distribution. Central Queensland, bays and shelf, 11-34 m; North-west Shelf, 39-82 m.

Remarks. Apanthura pultenaea is best recognised by its acute telson in which it resembles the south-eastern species, *A. isotoma* Poore and Lew Ton. It differs from this species in not possessing those features which characterise *Apanthura* species-group 2. That is, *Apanthura pultenaea* has fewer antennal setae than is typical of this group, fewer pereopodal setae and has a continuous uropodal endopod setal row. In general, the species is more like members of species-group 1 but does not have the characteristic antennal setation.

Three small specimens from the North-west Shelf are assigned to this species but have a more elongate uropodal endopod and broader exopod than is typical (Fig. 31, a). They may represent a distinct species but until a range of material from across the north coast of Australia is available intraspecific variation cannot be determined.

Apanthura restio sp. nov.

Figures 33, 34

Material examined. 5 males, 41 juveniles; 2.2-7.0 mm. Holotype. Juvenile, 6.8 mm, QM W12153(with slide).

Figure 29. *Apanthura kennedia.* Holotype juvenile.

Figure 30. *Apanthura kennedia.* Holotype juvenile.

Coral Sea Territory, Bennett Is., Chesterfield Reefs (19°55'S, 158°23'E), north end of lagoon, 1 m, N.L. Bruce, 8 May 1979.

Paratypes. Coral Sea Territory, Bennett Is., 12 m, N.L. Bruce, 6 May 1979, QM W12157(1); Long Is., Chesterfield Reefs (19°52'S, 158°19'E), 1-12 m, N.L. Bruce, May 1979, QM W12155(with slide, male, 7.0. mm), W12154(1), W12156(1).

Qld, Britomart Reef (18°17'S, 146°38'E), various localities: coral rubble, 5-15 m, G.C.B. Poore and H.M. Lew Ton, Nov 1982, NMV J12415(male, 5.0 mm), J12416(1), J12417(1 + male, 5.5 mm), J12419 (1), J12420(1), J12423(1). Fantome Is. (18°40'S, 146°31'E), coral rubble, 5-9 m, G.C.B. Poore and H.M. Lew Ton, Dec 1982, NMV J12413(with slide, male, 4.7 mm), J12414(13), J12421-2(6). Orpheus Is. (18°37'S, 146°29'E), coral rubble, 9 m, G.C.B. Poore and H.M. Lew Ton, Dec 1982, NMV J12424(3)

Other material. Qld, Lizard Is. (14°145'S, 145°28'E), B. Kensley, 28 May 1980, NMV J12428(male). Townsville bays (TBS stns), NMV collections(5). NE of Townsville, NMV J12430(1). Heron Is. (23°27'S, 151°55'E), QM W12158(3).

NT, McCluer Is. (11°06'S, 133°00'E), NMV 12425(1). Oxley Is. (11°00'S, 132°49'E), NTM Cr4066(1).

Diagnosis. Head, some pereonites and pleon with faint brown anastomosing dorsal pigment pattern. Antenna 1 peduncle with 1 seta on article 3. Pereopod 1 carpus with strong acute tooth; propodus palm axial, with tooth, with 7 mesial seate. Pereopod 2 merus with straight posterior margin; carpus with barely angled posterodistal margin; propodus rectangular. Pereopods 4-7 with very few posterior setae on merus and carpus. Uropodal endopod with continuous row of setae along lateral and distal margin; 1.4 times as long as greatest width. Exopod twice as long as wide, ventrodistal lobe acute, dorsal lobe shorter and separated by deep notch. Telson 1.4 times as long as pleon, twice as long as greatest width, lateral margins evenly convex, tapering to faintly truncate margin, flat, with transverse row of long setae at three-quarter mark.

Male. Antenna 1 flagellum of 7 articles reaching to middle of pereonite 1. Head with small chin (as in juvenile). Pereopod 1 barely modified. Pleon slightly elongated.

Distribution. Coral Sea islands, Great Barrier Reef, northern Australian shelf; 1-15 m.

Remarks. This small slightly coloured species is most easily distinguished by the transverse setal row on the telson. The species is widespread in the tropics. Although juveniles from different habitats or regions could not be differentiated males from some localities were larger than others. The species shows most of the characteristics of species-group 1 but male pereopods are barely modified.

Apanthura stipa sp. nov.

Figures 35, 36

Material examined. 4 males, 87 juveniles; 2.6-5.4 mm. Holotype. Juvenile, 4.2 mm, QM W12159(with slide).

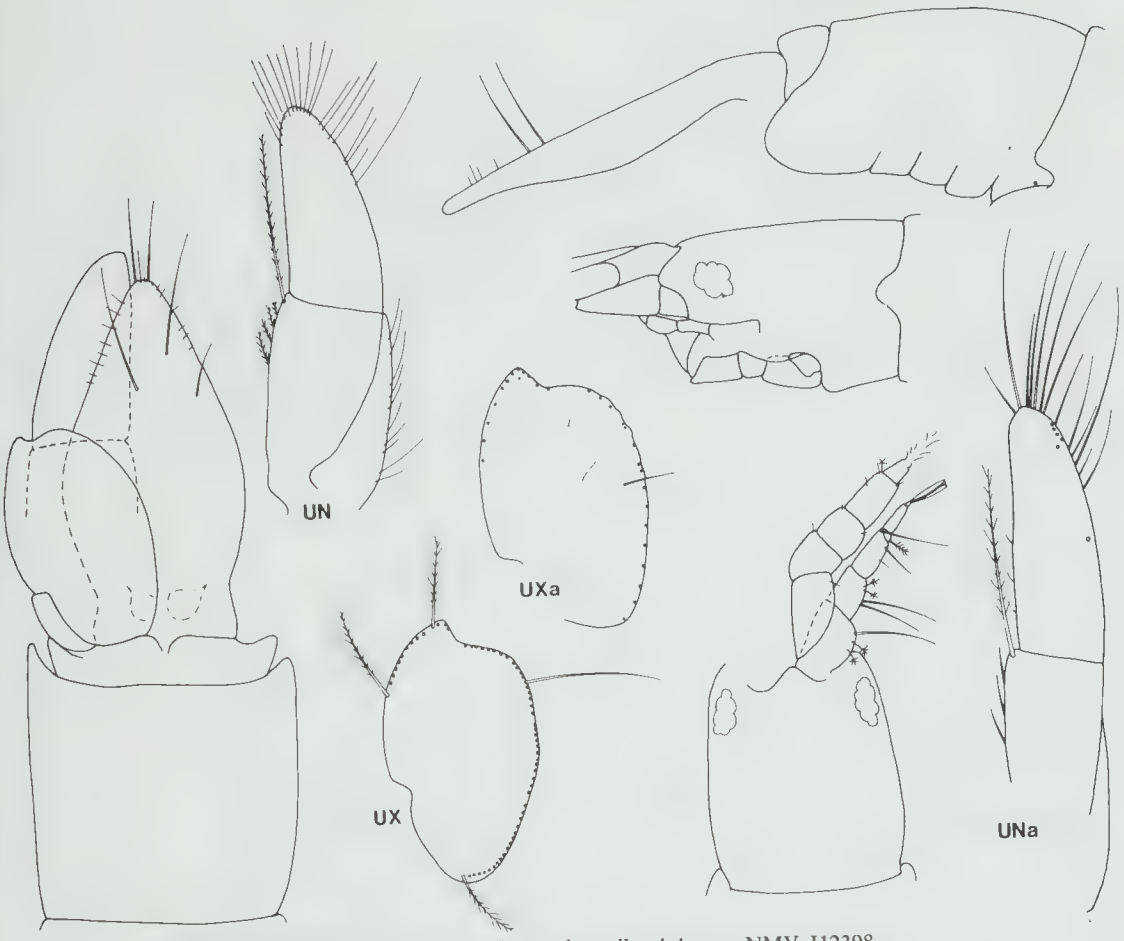

Figure 31. *Apanthura pultenaea.* Holotype juvenile; a, juvenile, 4.4 mm, NMV J12398.

Coral Sea Territory, Magdelaine Cays (16°30′S, 150°15.5′E), N.L. Bruce, 26 Apr 1979.

Paratypes. Coral Sea Territory, type locality, QM W12161(1); Lizard Is. (14°40′S, 145°28′E), B. Kensley, NMV J12432-J12446(77 including 2 males).

Other material. Qld, Heron Is. (23°27′S, 151°55′E), N.L. Bruce, QM (1).

NT, New Year Is. (10°54′S, 133°02′E), NTM Cr4063(male). McCluer Is. (11°06′S, 133°00′E), NMV J12451(1). East Point, Fannie Bay (11°24′S, 13°48′E), NMV J12448(1), J12449(male), J12452(2), NTM Cr4064(3), Cr4065(2). Locality unspecified, NMV J12450(1).

Diagnosis. Head, pereonites, pleon and telson with dorsal brown pigment patches. Antenna 1 peduncle with 2 long setae on article 2. Pereopod 1 carpus with blunt tooth; propodus palm axial proximally, with mid-distal rugose tooth closing on protuberance on dactyl, with 6 mesial setae. Pereopod 2 merus with straight posterior margin; carpus with straight posterodistal margin; propodus rectangular. Pereopods 4-7 with only few posterior setae on merus and carpus. Uropodal endopod with continuous row of setae along lateral and distal margin; 1.5 times as long as wide. Exopod 1.8 times as long as wide, ventrodistal lobe broadly acute, very shallow concavity separates dorsal lobe. Telson as long as pleon, twice as long as greatest width, broad proximally and tapering from midpoint to rounded apex, flat except for slight proximal dome, few dorsal setae distally.

Male. Head with strongly anteriorly produced chin, enlarged eyes. Antenna 1 flagellum of 7 articles with 0, 4, 7, 2, 0, 2, 2 aesthetascs respectively. Pereopod 1 propodus palm elongated, with pronounced tooth, dactylus with enlarged tooth. Pereopods 2-7 more elongate than in juvenile.

Distribution. Coral Sea, Great Barrier Reef and Northern Territory coral islands.

Figure 32. *Apanthura pultenaea.* Holotype juvenile.

Remarks. Apanthura stipa is immediately recognised by its patterned pigmentation and broad telson. The species is similar to *A. childi* (Kensley) originally described as a species of *Mesanthura* because of its pigmentation. This Fijian species differs in lacking a tooth on the palm of pereopod 1.

Most of the material from the Northern Territory differed from the types in a slightly narrower uropodal exopod but this was not the case for all.

The males of *Apanthura stipa* and of *A. childi* differ from those of most *Apanthura* in possessing few aesthetascs on each antennal article. Although juveniles are, like *A. restio,* compatible with those of *Apanthura* species-group 1 male pereopods are only slightly modified.

Acknowledgements

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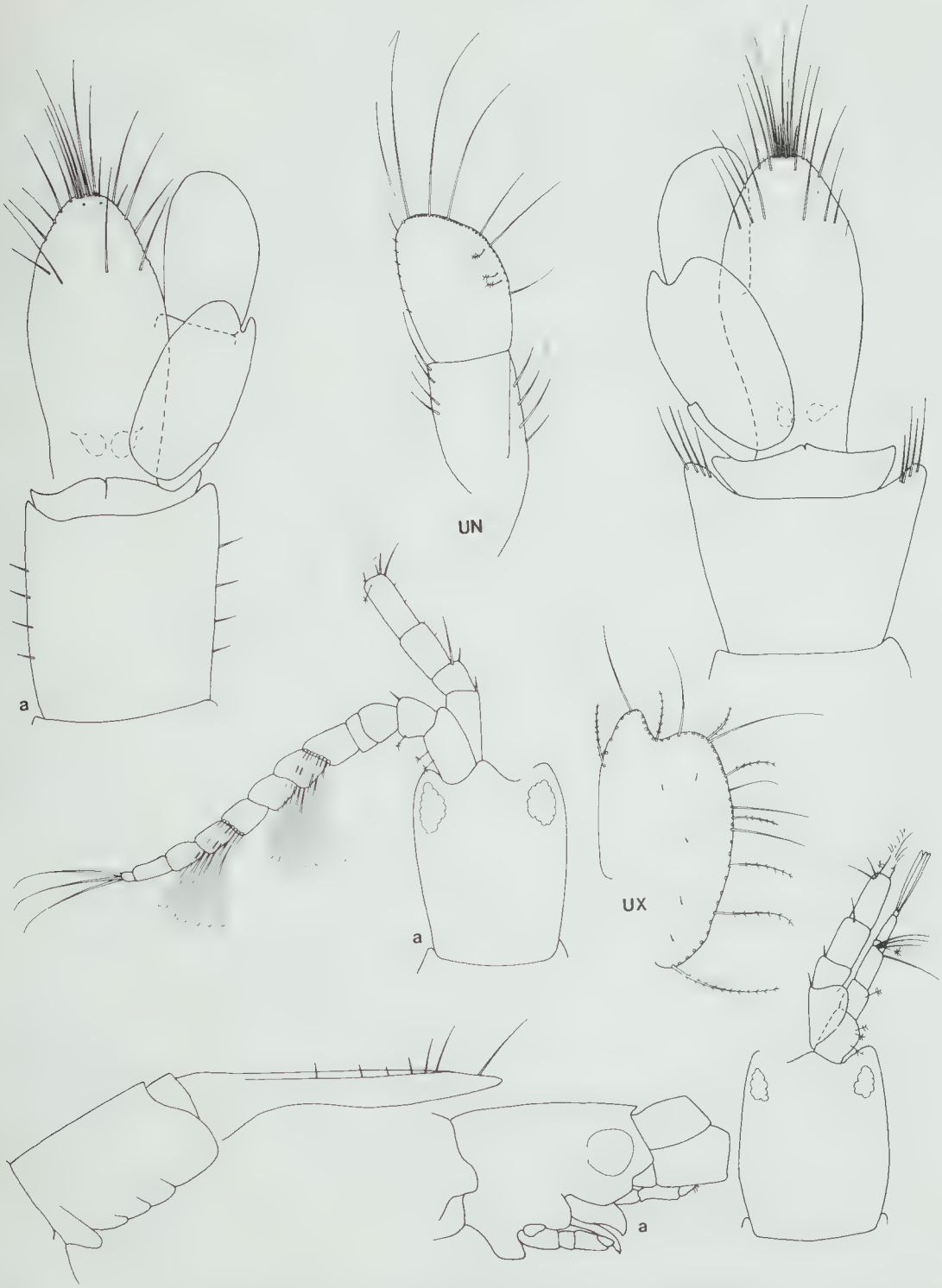

Figure 33. *Apanthura restio*. Holotype juvenile; a, paratype male, 7.0 mm, QM W12155.

Figure 34. *Apanthura restio*. Holotype juvenile; a, paratype male, 7.0 mm, QM W12155.

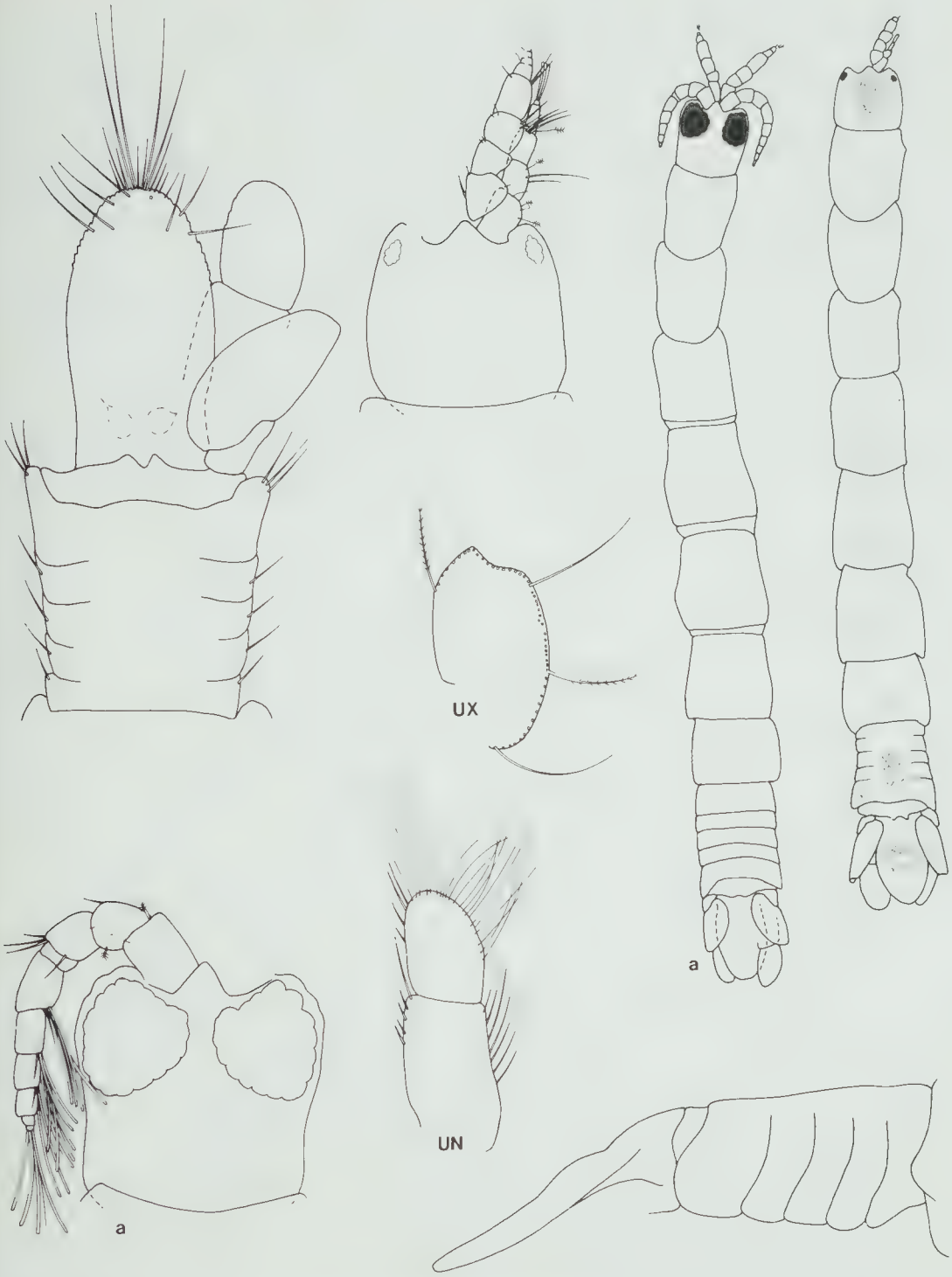

Figure 35. *Apanthura stipa*. Holotype juvenile; a, paratype male, NMV J12433.

Figure 36. *Apanthura stipa*. Holotype juvenile; a, paratype male, NMV J12433.

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TODARODES PACIFICUS PUSILLUS NEW SUBSPECIES (CEPHALOPODA: OMMASTREPHIDAE) FROM NORTHERN AUSTRALIA

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Abstract

Dunning, M., 1988. *Todarodes pacificus pusillus* new subspecies (Cephalopoda: Ommastrephidae) from northern Australia. *Memoirs of the Museum of Victoria* 49: 149-157

A new squid subspecies, *Todarodes pacificus pusillus,* is described from northern Australian continental shelf and upper slope waters on the basis of morphological differences and apparent geographic isolation from northern hemisphere populations of *T. pacificus* Steenstrup, 1880. Basic life history information is presented. The subspecies reaches maturity at less than 80 mm mantle length compared with greater than 200 mm ML for *T. pacificus* from Japanese waters.

Introduction

Seven species of arrow squid of the oegopsid family Ommastrephidae have been recorded from waters around Australia (Lu and Dunning, 1982). Small numbers of a previously unrecorded form were collected recently during research and exploratory fishing surveys in northern Australian waters. The specimens showed the general characters of the genus *Todarodes* Steenstrup, 1880, i.e., presence of simple foveola in the funnel groove with no side pockets, quadriserial suckers on the dactylus of the tentacular club, absence of light organs and hectocotylization of only the distal portion of the right ventral arm in males.

Three nominal species assigned to the genus *Todarodes* have been recorded from the Indo-Pacific region. *T. pacificus* Steenstrup, 1880 generally is considered to be restricted to waters adjacent to Japan (Okutani, 1980), *T. angolensis* Adam, 1962 occurs in oceanic and continental slope waters of the southern Tasman Sea and around South Africa (Dunning, unpublished data; Roper et al., 1984) and *T. filippovae* Adam, 1975 is abundant south of the Subtropical Convergence in the Indian and South Pacific Oceans (Dunning and Brandt, 1985).

Most measurements, indices and abbreviations follow Wormuth (1976). Counts of arm suckers were made using a binocular dissecting microscope and indices are expressed as a percentage of dorsal mantle length (ML) unless otherwise specified. Measurements of spermatophores are as defined by Roper and Voss (1983). Interpretation of tentacular club structure follows Roeleveld (1982) and the criteria described in Dunning and Brandt (1985) were used to assess reproductive condition. Type material is in the Museum of Victoria, Melbourne (NMV), Queensland Museum, Brisbane (QM), and the National Science Museum, Tokyo (NSMT).

Ommastrephidae Steenstrup, 1857

Todarodes Steenstrup, 1880

Type species. Todarodes pacificus Steenstrup, 1880.

Todarodes pacificus pusillus subsp. nov.

Figures 1, 2

Material examined. Holotype: Timor Sea (13°48′S, 124°19′E), bottom trawl in 102m, RV "Hai-Kung", 28 Mar 1981, NMV F31571 (male, ML 65 mm).

Paratypes: Timor Sea (8°53′S, 135°12′E), bottom trawl in 78 m,FRV "Soela", 27 Jun 1981, NMV F31569 (female, ML 64 mm); (9°52′S, 129°12′E), bottom trawl in 138 m, FRV "Soela", 9 Jul 1980, NMV F31570 (female, ML 64 mm).

Coral Sea (17°46.2′S, 146°50.2′E), FRV "Soela", 30 Nov 1985, QM Mo16359 (male, ML 68 mm); (17°16.1′S, 146°41.5′E), bottom trawl in 250 m, FRV "Soela", 1 Dec 1985, QM Mo16358 (female, ML 74 mm).

North-west Shelf (19°04′S, 118°57′E), bottom trawl in 82 m, FRV "Soela", 29 Aug 1983, QM Mo16357(male, ML 53 mm); (19°31′S, 116°02′E), bottom trawl in 130 m, FRV "Soela", 13 Oct 1983, NSMT Mo66640 (male, ML 53 mm); (19°31′S, 116°02′E), bottom trawl in 130 m, FRV "Soela", 13 Oct 1983, NSMT Mo66641(female, ML 61 mm).

Figure 1. Holotype of *Todarodes pacificus pusillus* new subspecies, 63 mm ML male from the Timor Sea. (Scale = 10 mm)

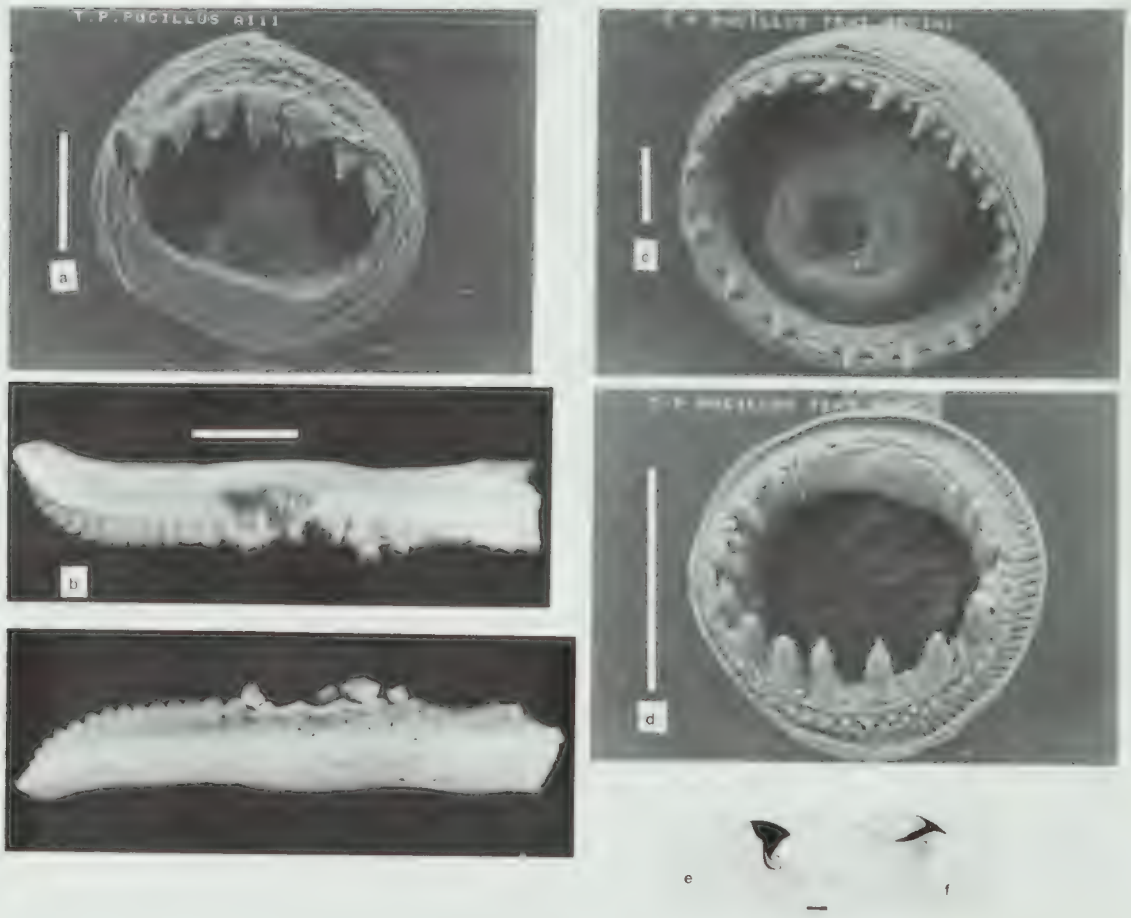

Figure 2. Arm III sucker (a), hectocotylized arm of a 68 mm ML male from off the northern Queensland coast (b), tentacular manus sucker (c), tentacular marginal sucker (d), upper (e) and lower (f) beaks. (a, c, d from the holotype, e, f from a 69 mm ML female from off the southern Queensland coast). (Scale = 0.25 mm for suckers and beaks, 5 mm for the arm)

Off southern Queensland (27°S, 153°45'E), bottom trawl in 120 m, FV "Harvest Moon", 5 Mar 1983, QM Mo13400 (female, ML 69 mm); (27°S, 153°45'E), bottom trawl in 150 m, FV "Harvest Moon", 27 Feb 1983, QM Mo13399(male, ML 62 mm).

Other material examined is listed in Appendix 1 and measurements of the type specimens of *T. p. pusillus* are shown in Table 1.

Description. Mantle cylindrical, slender, only moderately muscular, with abrupt caudal taper. Fins short rhombic. Head large, only slightly narrower than mantle. Mantle element of T-shaped locking device with straight ridge, no muscular fusion to funnel element. Funnel groove with simple foveola without side pockets.

Arms subequal and large, the longest (either II or III) slightly less than half the mantle length. Swimming keels present on aboral surface show greatest development on arms III. Basalmost arm sucker rings with 6-8 sharp subequal somewhat flattened teeth on distal half and smooth proximally. Toothed area increasing to approximately two-thirds on largest arm suckers which have 9-11 teeth. Protective membranes and their supports of uniform height, not higher than suckers.

Hectocotylization in males involving distal half of right ventral arm only. Arm slightly thicker and shorter than its partner. Dorsal aboral edge produced distally to form "spatula" at tip. 11-13 normal arm suckers present proximally. On distal half, suckers lost leaving prominent broad based trabeculae. In dorsal column, sucker stalks and bases disappear almost immediately but ventrally are still evident for at least 10 rows before fusing completely with trabeculae. Ventral trabeculae broaden and join together to form low serrated fan which diminishes in height rapidly at arm tip. Approximately 20 pairs of trabeculae present in modified section.

Tentacles approximately 1.5 times length of longest arm. Carpal suckers arranged as 2, 2, 1 on right club and 1, 2, 1 on left with similar dentition to largest arm suckers. Fixing apparatus absent. Suckers of manus in 6-8 quadriserial rows. Largest medial manus sucker rings with 16-18 moderately large subequal conical teeth interspersed with low horny plates, their diameters approximately 2.5 times those of adjacent marginal suckers. Proximally marginal suckers with a dentition similar to carpal suckers. By fourth manus row, they possess a complete ring of 18-20 sharp teeth somewhat larger laterally. Protective membrane beginning in carpal region never exceeds sucker height and its supports not strongly developed.

Chromatophores (of frozen specimens) chestnut brown on a silver-white background, smaller and more densely packed on fins and largest dorsally on mantle. A distinct deep blue-black dorsal stripe along the mantle midline broadening over head and extending anteriorly as thin stripes along aboral edges of dorsal and dorsolateral arms.

Light organs absent.

Spermatophores with sperm reservoir approximately equal to 40 % and cement body fifteen percent of spermatophore length. Cone at oral end of cement body in shape of an equilateral triangle.

Eggs ovoid, 1.2 mm maximum diameter.

Gladius with free rachis long and widest anteriorly, ending in a stiff, acute point. Posterior vanes reduced to a small spoon-shaped cone that accounts for slightly more than 10% of gladius length. Posterior end with a small conus.

Upper beak with deeply recessed jaw angle and moderate rostral edge. Wing base inserted halfway down anterior margin of lateral wall, crest strongly curved. Inner margin of hood wing almost straight and outer margin of rostral hood strongly curved.

Lower beak with recessed jaw angle barely visible in profile. Strong sharp knob present. Lateral wall with no apparent folds and hood notch moderately deep. Width of hood wing moderate and rostral edge slightly curved. Crest lateral wall moderately wide and crest fold strong.

Distribution. Australian continental shelf and upper slope north of 27°S at bottom depths between 78 and 357 m (Fig. 3).

Etymology. From the Latin *pusillus* (dwarf) referring to the small size at maturity of this subspecies relative to the North Pacific subspecies.

Discussion. Morphological characters of the Australian specimens were compared with those of specimens of Japanese common squid, *T. pacificus* Steenstrup, 1880, and the larger "neritooceanic" forms, *T. angolensis* Adam, 1962 and *T. filippovae* Adam, 1975. The specimens from northern Australian waters are separated from the last two on the basis of fin proportions (fin length index 24-31 compared with 51-55 for *filippovae*, 48-53 for *angolensis*, fin width index 42-50 compared with 55-63 for *filippovae*, 51-64 for *angolensis*), medial tentacular sucker dentition (18-20 teeth compared with 13-15 in *angolensis* and 10-13 in *filippovae*) and on the number of quadriserial sucker rows on the tentacles (6-7 compared with 12-13 in both *angolensis* and *filippovae*).

Table 1. Measurements and counts of *Todarodes pacificus pusillus* subsp. nov.

ML – Dorsal mantle length, MWI – Mantle width index, FLI – Fin length index, FWI – Fin width index, FA – Fin angle, HLI – Head length index, HWI – Head width index, IRAI – Right arm I length index, SR(IRA)I – Largest sucker on IRA diameter index, ISC – Sucker rows on IRA, IIISC – Sucker rows on IIIRA, SR(RT)I – Largest right tentacular sucker diameter index, ClLI – Club length index, MaSC – Sucker rows on the manus of the right tentacle, Arm formula – Lengths of the arms, HcLI – Length of the hectocotylized portion relative to the arm length, HDC – Sucker rows in the dorsal column of the hectocotylized arm, HVC – As previous but ventral column, SpLI – Spermatophore length index, SpWI – Spermatophore width index, SpRI – Sperm reservoir index.

	Holotype NMV F31571	Paratypes NMV F31570	NMV F31569	QM Mo13400	QM Mo13399	QM Mo16357	NSMT Mo66640	NSMT Mo66641	QM Mo16358	QM Mo16359
ML (mm)	65	63	64	69	62	53	53	61	74	68
Sex	M	M	F	F	M	M	M	F	F	M
MWI	22	21	24	–	–	24	29	28	23	21
FLI	30	29	30	25	27	27	27	31	26	29
FWI	48	47	50	45	45	49	48	48	45	43
FA	58°	59°	63°	61°	60°	62°	56°	64°	59	56
HLI	21	23	21	18	24	21	22	23	19	25
HWI	18	18	20	19	22	18	19	21	22	23
IRAI	33	31	36	36	35	34	44	30	30	30
SR(IRA)I	1.7	1.3	1.6	1.7	1.8	1.5	1.5	1.8	1.4	1.3
ISC	17	14	16	13	13	17	17	16	16	15
IIISC	16	17	19	17	17	17	16	17	17	17
SR(RT)I	2.6	2.1	2.8	2.9	2.9	2.6	3.0	2.8	2.4	2.5
ClLI	46	44	40	–	–	41	39	40	-	
MASC (rows)	–	–	7	–	6	7	–	7	7	6
Arm Formula	3≈2>4>1	3≈2>4>1	3≈2>4>1	3≈2>4>1	2≈3>4>1	2≈3>4>1	3≈2>4>1	3≈2>4>1	–	-
HcLI	45	47	–	–	57	49	45	–		49
HDC	6	6	–	–	5	6	5	–	–	5
HVC	7	7	–	–	6	7	8	–		4
SpLI	11	–	–	–	11	10	12	–	–	–
SpWI	8.4	–	–	–	–	6.6	5.7	–		–
SpRI	36	–	–	–	–	41	–	–	–	–

Todarodes pacificus was described from specimens from east of Hokkaido and subsequent workers have considered it restricted to temperate shelf and upper slope waters in the northern North Pacific, principally around Japan (Sasaki, 1929; Voss, 1963; Clarke, 1966; Wormuth, 1976; Okutani, 1980; Roper et al. 1984) (Fig. 3). Occasionally this species has been reported from the South China Sea (Shojima, 1970; Tung, 1977) and around Hong Kong (Voss and Williamson, 1971). The paratype of *Nototodarus sloani philippinensis* Voss, 1962 from the southern Philippines should be referred to *T. pacificus* (Dunning, 1988). "Juvenile" *T. pacificus* were reported by Rancurel (1976) from the stomachs of yellowfin tuna caught in the north-west Coral Sea but these specimens were not available to the author for examination. With the exception of the above, no records of *T. pacificus* from south of 5°45′ have been found in the literature.

Comparison of the Australian specimens with specimens of *T. pacificus* from Japan, Taiwan and Hong Kong, with the paratype of *N. sloani philippinensis* and with values reported in the literature is presented in Table 2. It should be noted that since body proportions change with growth, more valid comparisons can be made among specimens of the same mantle length. However, the effect of the advanced state of reproductive maturity of the Australian specimens should also be taken into account.

Specimens from Hong Kong and Taiwan and the paratype of *N. sloani philippinensis* are intermediate in some characters and in size at maturity between the Australian and Japanese specimens. However, they show greater affinity with Japanese specimens in fin proportions, tentacular manus and arm sucker counts and size of arm suckers.

The simple structure of the hectocotylus of Australian males is not significantly different from that of Japanese males described and illustrated by Ishikawa (1913), Sasaki (1929) and Wormuth (1976) or from the hectocotylus of a 62 mm ML male from off Hong Kong. The right ventral arm of a 68 mm male from the Coral Sea is illustrated in Figure 2. In Australian specimens, a significantly greater proportion of the ventral arm is modified and the number of proximal suckers present is significantly fewer than for *T. pacificus* from Japanese waters.

Although less than 80 mm ML and weighing less than 15 g, the majority of the Australian specimens examined were mature. The oviducts and ovary of a recently copulated 64 mm ML female (Fig. 4) contained approximately 3000 ova between 0.75 and 1.20 mm maximum diameter (gravimetric extrapolation of egg count). All females larger than 60 mm ML were mature and all males greater than 50 mm ML carried fully formed spermatophores in their spermatophoric sacs (40 spermatophores in a male 75 mm ML).

Of the 103 specimens of *T. p. pusillus* examined 49 individuals were female and 59 male. Neither size disparity between sexes nor geographic separation was apparent in the material examined. Female *T. pacificus* from Japanese waters attain slightly greater mantle lengths than contemporary males and in exploited stocks usually outnumber males (Okutani, 1983).

Variation in size at maturity has been observed in northern hemisphere populations of *T. pacificus*. In Japanese waters, females reach maturity between 190 and 300 mm ML dependent on whether they belong to the so-called "winter", "autumn" and "summer" populations. Males reach maturity at more than 200 mm ML (Hamabe et al., 1974). Shojima (1970, Plate 11, figs. 8, 9) illustrated females of 138 and 152 mm ML from the South China Sea, evidently mature with well developed nidamental glands and eggs in their oviducts.

High water temperatures and increased day length have been related to accelerated maturation in cephalopods. Mangold (1966) observed that higher water temperature regimes and increased photo-period accelerated growth and maturation in *Sepia* in the Mediterranean and the physiological basis of this phenomenon was elucidated by Richard (1966). Other ommastrephids are also reported to display this phenomenon (O'Dor et al., 1977).

Around Japan, *T. pacificus* is not generally abundant where temperature at 50 m depth exceeds 15°C and it has been caught where temperatures are as low as 5°C (Kasahara and Nasumi, 1976). The Australian specimens were caught where temperatures at 50 m depth were in excess of 23°C, and surface temperatures reach 29°C in summer. Higher temperatures and an increased average day length at the lower latitudes of northern Australian waters may have contributed to the precious maturation of this subspecies of *T. pacificus*.

Aknowledgements

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Table 2. Morphometric comparison of *T. pacificus pusillus* from northern Australian waters with *T. pacificus* from Japan, Taiwan, Hong Kong and the Philippines.

	T. pacificus pusillus N. Australia				Japanese juveniles				*T. pacificus pacificus* Adults (Wormuth, 1976)				Hong Kong		Taiwan	Philippines
	Median	Max.	Min.	N	Median	Max.	Min.	N	Mean (Median)	Max.	Min.	N				
ML (mm)	–	76.5	52	25	–	78	42.4	8	*	*	*	–	62(M)	81(F)	151(M)	101(F)
MWI	24	29	21	15	19	23	18	6	17.5	19	16	14	–	22	–	19
FLI	27	31	24	23	34	37	30	8	41.5	45	39	14	35	34	39	33
FWI	45	50	42	23	45	47	41	8	55.2	58	49	14	50	46	50	45
FA	59	64°	56°	11	49°	52°	46°	8	(52°)	62°	45°	14	43°	46°	–	52°
HLI	21	25	17	17	16.5	20	11	8	13.2	15	11	14	–	19	20	19
HWI	21	23	18	17	18	21	15	6	16.5	18	15	14	–	–	–	20
IRAI	31	44	28	24	27.5	31	27	8	35.9	38	32	14	29	33	–	28
SR(IRA)I	1.5	2	1	23	1.2	1.4	1.1	8	0.8	1.1	0.7	14	–	–	–	1.4
ISC	15	17	12	23	28.5	37	25	8	(47)	52	44	14	–	–	–	21
IIISC	17	19	12	23	28	36	26	8	–	–	–	–	25	27	–	23
SR(RT)I	2.5	3	2.1	20	2.2	2.6	1.8	8	2.3	2.7	1.9	14	2.2	–	–	2.2
CIL1	40.5	46	39	6	26	27	24	3	33.8	41	28	14	36	–	–	31
MaSC (rows)	7	7	6	17	10	10	9	5	–	–	–	–	–	–	–	9
Arm Formula	3≈2>4>1	–	–	7	2≈3>1>4	–	–	8	2≈3>4≈1	–	–	–	2>3>4>1	–	–	2≈3>1>4
HcLI	44	57	31	14	–	–	–	–	–	–	–	–	39	–	34	–
HDC	5	6	4	14	–	–	–	–	(24)	29	18	4	10	–	12	–
HVC	6	8	5	14	–	–	–	–	(26)	32	25	4	10	–	13	–
SpLI	11	12	11	4												
SpWI	6.6	8.4	5.7	3												
SpRI	–	41	36	2												

* males 172.5-230 mm ML, females 151.5-261.5 mm ML

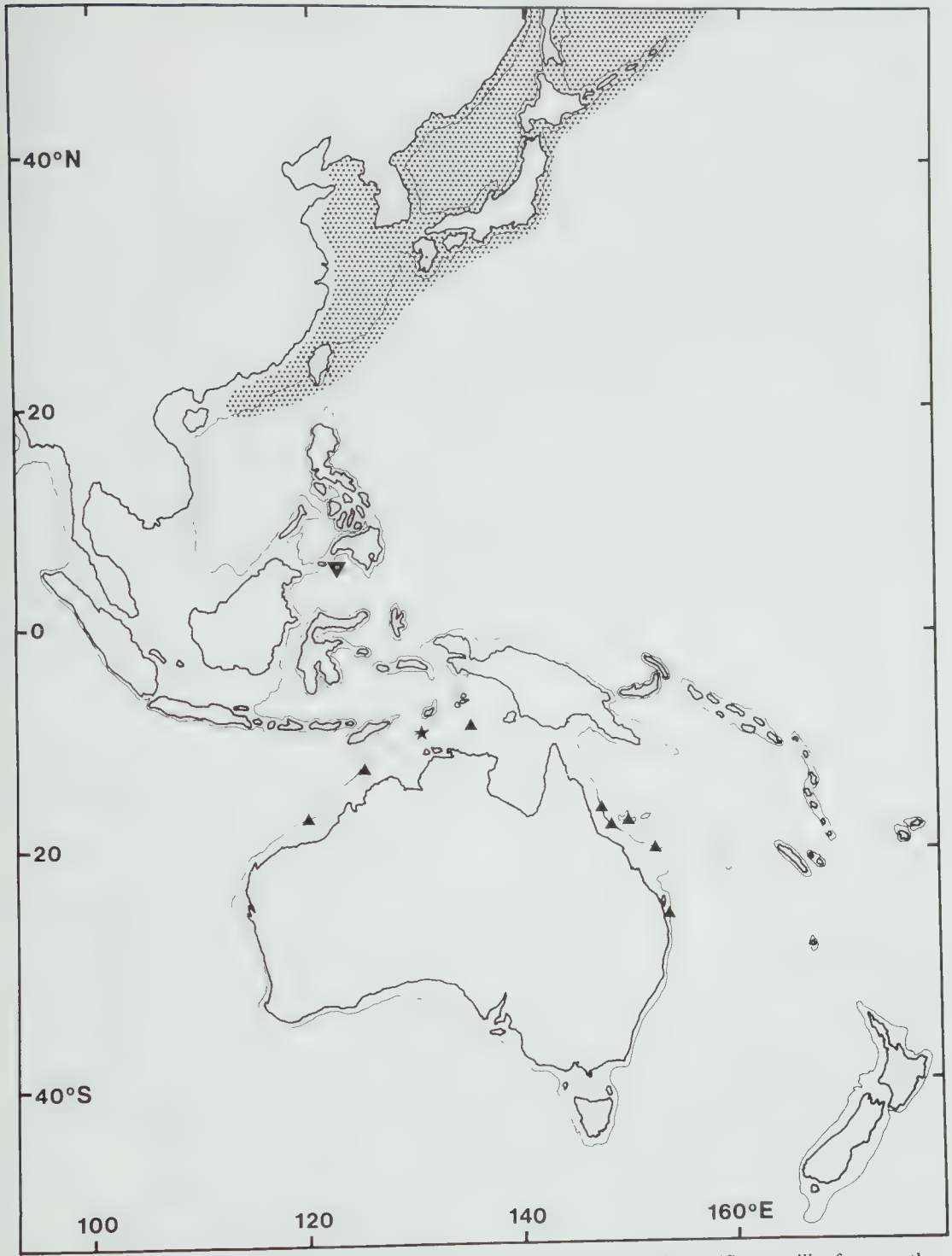

Figure 3. Capture localities of the holotype (star), other specimens of *Todarodes pacificus pusillus* from northern Australian waters (triangles) and the paratype of *Nototodarus sloani philippinensis* Voss, 1962 from the southern Philippines (inverted triangle).

Figure 4. Mature 64 mm ML female *Todarodes pacificus pusillus* from the Timor Sea, June 1981. (Scale = 10 mm)

Prof. T. Okutani, Tokyo University of Fisheries and Dr T. Kubodera, National Science Museum, Tokyo kindly provided suggestions and also comparative material of *T. pacificus* from Japanese waters.

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Appendix 1. Other material examined.

Todarodes pacificus Steenstrup, 1880

3 juveniles, ML 42-75 mm, North-west Pacific, south-east of Japan (38°15.5′N, 155°01.5′E), RV "Soyo-maru", surface scoop net, 24 May 1972, NMV F52555;

5 juveniles, ML 53-78 mm, North-west Pacific, off Fukushima Prefecture, Japan, surface scoop net, June 1985, QM Mo16360;

Female, ML 101 mm, Off Jolo Island, Philippines (~5°45′N,121°40′E), "Albatross", bottom trawl in 294 m, 7 February 1908, United States National Museum 575452 (Paratype of *Nototodarus sloani philippinensis* Voss, 1962);

Male, ML 151 mm, Off Pingtou, Taiwan, bottom trawl, October 1971, NMV F30321;

Male and female, ML 62,81 mm, South China Sea, off Hong Kong (19°05′N, 115°15′E), RV "Tai-shun", bottom trawl in 120 m, 8 April 1983, Australian Museum C140404;

Todarodes pacificus pusillus subsp. nov.

3 males and 6 females, ML 58-63, 64-74 mm, Coral Sea (17°46.2′S, 146°50.2′E), FRV "Soela", bottom trawl in 201 m, 30 November 1985, NMV F52542;

4 males, ML 61-72 mm, Coral Sea (17°16.1′S, 146°41.5′E), FRV "Soela", bottom trawl in 250 m, 1 December 1985, NMV F52543;

Male, ML 77 mm, Coral Sea (17°36.5′S, 150°10.3′E), FRV "Soela", bottom trawl in 224 m, 4 December 1985, NMV F52544;

Male and 3 females, ML 61, 52-72 mm, Coral Sea (18°00.7′S,147°01.4′E), FRV "Soela", bottom trawl in 203 m, 29 November 1985, NMV F52545;

4 males and 4 females, ML 49-66, 68-76 mm, Coral Sea (18°40.8′S,148°02.8′E), FRV "Soela", bottom trawl in 204 m, 9 December 1985, NMV F52546;

2 females, ML 60 and 69 mm, Coral Sea (17°43.7′S, 146°52.8′E), FRV "Soela", bottom trawl in 302 m, 30 November 1985, NMV F52547;

2 females, ML 66 and 71 mm, Coral Sea (18°39′S, 148°03.4′E), FRV "Soela", bottom trawl in 204 m, 9 December 1985, NMV F52548;

Male, ML 66 mm, Coral Sea (17°55.8′S, 146°58.2′E), FRV "Soela", bottom trawl in 250 m, 30 November 1985, NMV F52549;

Male and 2 females, ML 55, 60, 65 mm, Coral Sea (18°05′S, 147°10.8′E), FRV "Soela", bottom trawl in 248 m, 8 December 1985, NMV F52550;

Male and 3 females, ML 64, 66, 72, 72 mm, Coral Sea (17°53.7′S,146°53.9′E), FRV "Soela", bottom trawl in 162 m, 1 December 1985, NMV F52552;

Female, ML 58 mm, Coral Sea (19°57.4′S, 151°44.4′E), FRV "Soela", bottom trawl in 357 m, 30 November 1985, NMV F52553;

36 males and 18 females, ML 64-75mm and 61-82 mm, Coral Sea (17°59′S,147°E), FRV "Soela", bottom trawl in 220 m, 8 January 1986, NMV F53156;

Male, ML 77 mm, Coral Sea (18°S, 147°01′E), FRV "Soela", bottom trawl in 224 m, 8 January 1986, NMV F53157;

Male and female, ML 69, 72 mm, Coral Sea (17°59′S, 147°E), FRV "Soela", bottom trawl in 218 m, 9 January 1986, NMV F53158.

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FIRST RECORDS OF *NOTOTODARUS HAWAIIENSIS* (BERRY, 1912) (CEPHALOPODA: OMMASTREPHIDAE) FROM NORTHERN AUSTRALIA WITH A RECONSIDERATION OF THE IDENTITY OF *N. SLOANI PHILIPPINENSIS* VOSS, 1962

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Abstract

Dunning, M., 1988. First records of *Nototodarus hawaiiensis* (Berry, 1912) (Cephalopoda: Ommastrephidae) from northern Australia with a reconsideration of the identity of *N. sloani philippinensis* Voss, 1962. *Memoirs of the Museum of Victoria* 49: 159-168.

Nototodarus hawaiiensis (Berry, 1912) is reported for the first time from northern Australian continental slope waters and distribution and life history are discussed. Re-examination of the holotype of *N. sloani philippinensis* Voss, 1962 confirms that this subspecies is a junior synonym of *N. hawaiiensis* and that the paratype is referrable to *Todarodes pacificus* Steenstrup, 1880.

Introduction

Recent exploratory trawling for deep-water crustaceans in north-western and north-eastern Australian continental slope waters yielded significant numbers of a large ommastrephid squid, assigned to the genus *Nototodarus* Pfeffer, 1912 on the basis of the simple foveola in the funnel groove, absence of light organs and hectocotylization of both ventral arms in males. Additional specimens were identified from off the New South Wales coast in the collections of the Australian Museum, Sydney.

Brief review of the distribution of Nototodarus *species*

Six nominal forms of the genus *Nototodarus* have been described from continental shelf and slope waters of the Indo-Pacific region.

N. gouldi (McCoy, 1888) is the dominant squid in continental shelf waters of southern Australia. Its known distribution extends as far north as 27°S off the east coast and at least as far as 25°S off the west coast (Lu and Dunning, 1982). Berry (1918) provided a detailed morphological description of post-juvenile growth stages of this species.

N. hawaiiensis (Berry, 1912) has been reported from the Hawaiian and Midway Islands (Berry, 1912, 1914; Wormuth, 1976; Young, 1978), and the South China Sea (Dong, 1963). Its distribution throughout the island chains of the central Pacific remains unclear although Okutani and Kuroiwa (1985) tentatively assigned to this species specimens taken on jigs at a seamount off the coast of Chile.

N. nipponicus Okutani and Uemura, 1973 was described from jig-caught specimens from southern Honshu, Japan. *N. nipponicus* was characterised by "rough" skin, a very broad fin relative to mantle length and large fin angle. In a recent paper, Okutani and Kuroiwa (1985) considered *N. nipponicus* to be a junior synonym of *N. philippinensis*.

The identity of a fourth nominal species, *N. insignis* (Gould, 1852), described from "Feejee Islands; Antarctic Seas" remains to be clarified. Pfeffer (1912) erected the genus *Nototodarus* based on a single male specimen assigned to *Ommastrephes insignis* from the south-east coast of New Zealand. However, Gould's type specimen was not examined by Pfeffer. It has not been redescribed and its present location is unknown.

Names of the two (or according to some authors, three) forms of *Nototodarus* occurring in New Zealand waters are confused (Tung, 1977; Kawakami and Okutani, 1981; Smith et al., 1981). The nomenclature currently is being reviewed (R.H. Mattlin, pers. comm.), but the morphological characteristics of the dominant forms and their distributions are well defined (Smith, 1985). The form predominating off the north-west coast of new Zealand is morphologically identical to the southern Australian *N.gouldi*, with the form from the east coast of New Zealand referred to as *N.*

sloani (Gray, 1849) showing the characteristics clearly described and illustrated by Pfeffer (1912) for *N. insignis* (R.H. Mattlin, pers. comm.).

N. sloani philippinensis Voss, 1962 has been recorded from slope waters around the Philippines and Hong Kong (Voss, 1963; Voss and Williamson, 1971). Perera (1975) assigned squid specimens taken by jig from off Sri Lanka to this subspecies. However the sessile arm and tentacular club suckers illustrated in figure 10, p. 58, are characteristic of the subfamily Ommastrephinae rather than Todarodinae casting doubt on the validity of this identification.

Differences between *N. gouldi* and the form currently identified as *N. sloani* are clearly presented by Smith et al. (1981, Fig.2, p. 249) and Kawakami and Okutani (1981: 22-28, Fig. 1). With the exception of the structure of the hectocotylus, characters that separate *N. hawaiiensis* and *N. gouldi* were well described by Berry (1918: 242-243). However, morphological differences between *N. hawaiiensis* and *N. sloani philippinensis* remain unclear. In light of our recent understanding of morphological characters useful in separating species of the genus *Nototodarus* (Smith et al., 1981; R.H. Mattlin, pers. comm.; M.A. Roeleveld, pers. comm.), the types of these nominal species were re-examined for the present study.

Material examined

Specimens from northern Australian waters examined during this study were collected by the CSIRO Research Vessel "Soela" and New South Wales Fisheries RV "Kapala" with demersal fish and deep-water lobster trawls, the commercial trawlers FV "Craigmin" and FV "Iron Summer" with prawn trawls and from the Japanese RV "Hoyo-maru" No. 81 using a hand held scoop net. Collecting locations are shown in Figure 1 and details presented in Appendix 1.

The majority of measurements and indices used in this study follow Wormuth (1976). Counts of arm suckers were made using a binocular dissecting microscope and indices are expressed as a proportion of dorsal mantle length (ML) unless otherwise specified. Interpretation of tentacular club structure agrees with that proposed by Roeleveld (1982) and the criteria described in Dunning and Brandt (1985) were used to assess reproductive condition.

Results and discussion

Reconsideration of N. sloani philippinensis *Voss, 1962*

The structure of the hectocotylus has been shown to be of major taxonomic importance within the family Ommastrephidae and particularly within the genus *Nototodarus* (Adam, 1960; M.A. Roeleveld, pers. comm.). However, both *N. hawaiiensis* and *N. sloani philippinensis* were originally described from female specimens. Wormuth (1976) described the hectocotylus of *N. hawaiiensis*, but the form of the modification of the ventral arms of *N. philippinensis* has not been described in detail in the literature. The general description given by Voss and Williamson (1971: 70) is nonspecific, viz. "the left arm is modified only basally by the enlargement of the protective membrane supports. The right arm is modified similarly basally but on the distal half the suckers are modified into long papillae forming a comb-like structure."

Voss (1962) distinguished *N.sloani philippinensis* from *N. hawaiiensis* and *N. gouldi* (which he considered as subspecies of *N. sloani*) on the basis of the dentition of the arm and tentacular suckers. *N. sloani philippinensis* differs from the form from the east coast of New Zealand currently referred to as *Nototodarus sloani* (Kawakami and Okutani, 1981; Smith et al., 1981; R.H. Mattlin, pers. comm.) (Table 1). These differences are sufficiently significant to recognize *N. sloani* and *N. philippinensis* as distinct species.

Comparison of N. philippinensis *with* N. hawaiiensis

To clarify the morphological differences between them, the holotype and paratype of *N. philippinensis* and the holotype and one additional specimen of *N. hawaiiensis* described by Berry (1914) were re-examined (Table 2).

In the holotypes of both species, approximately 20 pairs of suckers are present on the right dorsolateral arms. Sucker rings in both progress from being almost smooth in row one through the development of slightly raised low ridges on the distal half in row two to separate conical teeth in row three, a single much larger medial tooth being flanked by three to four smaller teeth. Low ridges appear on row four which by row six are developed as low triangular rather than conical teeth. Largest suckers are in rows seven and eight and possess 19 to 21 teeth in both specimens. From these rows distally, the proximal triangular tooth margins of the rings begin to degenerate and the distal conical teeth become more equal in size. From row nine onward,

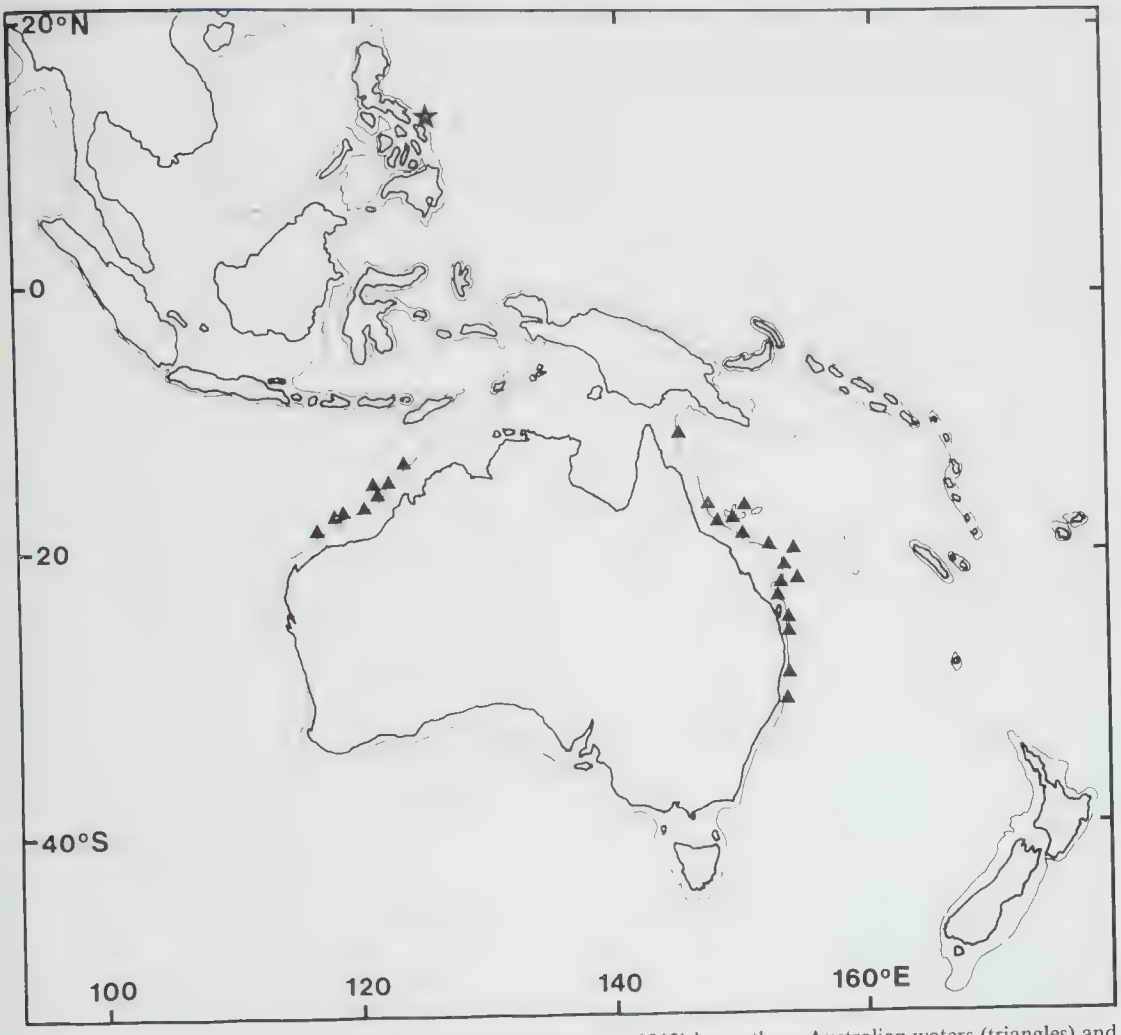

Figure 1. Capture localities of *Nototodarus hawaiiensis* (Berry, 1912) in northern Australian waters (triangles) and of the type specimen of *N. sloani philippinensis* Voss, 1962 (star) off the east coast of Luzon, Philippines.

only the conical teeth on the distal margin remain and curve more markedly inward.

Minute denticles interspersed among the distal teeth are rare and not consistently present even between the partners in an arm sucker row in the holotype of *N. hawaiiensis* and do not occur in the additional specimen examined (Berry No. 383; USNM 214617). (An additional specimen, Berry No. 248 (USNM 214632) is not a *Nototodarus*. Although poorly preserved, knobs of the fixing apparatus are evident on both tentacles and evidence exists of side pockets in the funnel groove. These characters place this specimen in the subfamily Ommastrephinae).

No differences between the holotypes are evident in the tentacular sucker dentition. Both have median manus sucker rings with 13 to 18 acutely pointed inwardly curved teeth, triangular proximally and more conical on the distal margin with a single much larger tooth distalmost. These teeth regularly alternate with low, wide curved plates in both specimens. Largest marginal manus suckers in each specimen have 19 to 21 equal pointed teeth alternating with small sometimes sharp denticles.

Sucker rings in the carpal region of the tentacles of both holotypes have an identical structure to those of the distal arm suckers. The sucker arrangement in both is left: 1,2,1 and right: 2,2,1;

Table 1. Measurements and counts for the holotype and paratype of *N. sloani philippinensis* Voss, 1962 and the holotype and an additional specimen (Berry No. 383) of *N. hawaiiensis* (Berry, 1912).

	Holotype *N. s. philippinensis* USNM 575451*	Paratype *N. s philippinensis* USNM 575452	Holotype *N. hawaiiensis* USNM 214382	Berry No. 383 *N. hawaiiensis* USNM 214617
ML (mm)	180	101	138	116
Sex	F	F	F	F
MWI	25	19	24	–
FLI	36	33	38	32
FWI	55	45	55	45
FA	52°	52°	51°	–
HLI	24	19	20	28
HWI	28	20	27	24
IRAI	33	28	45	37
SR(IRA)I	2	1.4	2	2
ISC	19	16	19	19
IISC	21	19	18	20
SR(RT)I	3.3	2.4	3.4	3.0
CILI	47	31	–	–
MaSC (rows)	10	9	11	11
Arm Formula	3>2>1>4	2=3>1>4	2>3>1>4	2=3>1=4

* United States National Museum of Natural History.

Table 2. Morphological comparison of *Nototodarus sloani philippinensis* and *N. sloani*

	*N. sloani**	*N. philippinensis*†
Arm sucker count	>60	22
Head length index	<20	24
Head width index	<24	28
Arm I sucker index	<1.2	1.6
Tentacle sucker index	<2.5	3.3
Fin length index	>42	35.5
Arm and tentacular sucker teeth	approximately equal	single much larger tooth
Teeth largest medial manus sucker	12-15	14-18
Quadriserial rows of manus	12-13	10
Skin	"smooth"	"rough"

* Includes values from Kawakami and Okutani (1981) and Wormuth (1976).
† Values for the holotype.

the basic pattern in ommastrephids according to Roeleveld (1982). Voss' holotype has ten quadriserial manus rows and the holotype of *N. hawaiiensis* eleven. (Three specimens of *N. hawaiiensis* from Hawaiian waters had either ten or eleven manus rows.)

The paratype of *N. philippinensis* differs from the holotype as noted in the original description (viz. 18 to 20 equal conical teeth in the medial manus suckers compared with 14 to 18 with one much larger in the holotype; arm suckers without variation in tooth ring structure), the "rough" skin present in the holotypes of *N. philippinensis* and *N. hawaiiensis* (Figure 2) (also characteristic of *N. nipponicus*) is absent. Suckers of the arms and tentacles are proportionally smaller and mantle and fin proportions are different. I conclude that this specimen is referrable to *Todarodes pacificus* Steenstrup, 1880.

Figure 2. Holotypes of *Nototodarus sloani philippinensis* and *N. hawaiiensis* showing the "rough" skin of the mantle and head. (Scale = 50 mm)

I do not consider the morphological differences between the holotype of *N. philippinensis* and the holotype and an additional specimen of *N. hawaiiensis* examined by Berry (1914) sufficient to justify their separation into separate species. *N. philippinensis* Voss, 1962 therefore is a junior synonym of *N. hawaiiensis* (Berry, 1912).

These conclusions are summarised in the following synonymy:

?Ommastrephes sloanei.—Schauinsland, 1899: 92.

Ommastrephes sagittata near *sloanei.*—Berry, 1909: 418.

?Ommastostrephes sloanei sloanei.—Pfeffer, 1912: 458-9 (in part).

Ommastrephes hawaiiensis Berry, 1912: 434, 437.

Nototodarus sloani philippinensis Voss, 1962: 175.

Nototodarus sloani hawaiiensis.—Voss, 1962: 175.

Nototodarus hawaiiensis.—Wormuth, 1976: 2, 17-21, Fig. 3.

Northern Australian Nototodarus

Measurements and counts of representative specimens from northern Australian waters are compared with data from Table 1, from the literature for *N. hawaiiensis* and *N. gouldi* and from additional specimens from Hawaiian waters in Table 3. The form of hectocotylization in males was compared with that described by Wormuth (1976) for *N. hawaiiensis,* by Berry (1918) for *N. gouldi* and Smith et al. (1981) for *N. sloani.*

The northern Australian *Nototodarus* specimens differ from *N. gouldi* (McCoy, 1888), the common ommastrephid of southern continental shelf waters, and from the so-called *N. sloani* in the larger size of its head relative to mantle length, the smaller number of sucker rows on the sessile arms in specimens of similar size, the dentition of the suckers of the arms and tentacles and the structure of the hectocotylus in males as shown in Table 3 and Figure 3.

All specimens from northern Australian waters have "rough" skin both in the fresh as well as preserved specimens. This condition has not been observed by the author in several hundred fresh and

Table 3. Comparison of measurements and counts for *Nototodarus* specimens from northern Australian waters, New Zealand *N. sloani*, southern Australian and New Zealand *N. gouldi* and additional specimens of *N.hawaiiensis* from Hawaii

	N. hawaiiensis (Northern Australia)	*N. hawaiiensis*† (Hawaii)	*N. sloani**	*N. gouldi**
Arm I sucker count	21-28	19-27	>60	35-50
Head length index	19-28	23-31	<20	16-20
Head width index	23-30	21-30	<24	18-22
Arm I sucker index	1.7-2.2	1.5-2.3	<1.5	<1.5
Tentacle sucker index	3.0-3.7	2.8-3.6	<2.5	<3.0
Fin length index	35-43	35-40	>42	>40
Arm and tentacular sucker teeth	single much larger tooth	single much larger tooth	approximately equal	approximately equal
Teeth largest medial manus sucker	14-18	14-16	12-15	12-15
Quadriserial rows of manus	10-11	10-11	12-13	12-13
Skin	"rough"	"rough"	"smooth"	"smooth"
Hectocotylus				
Proximal sucker bases enlarged as cushions	≈4-5 pairs	≈4-5 pairs	≈10 pairs	≈5-6 pairs
Normal sucker rows	1-6	1-5	≈5	≈5
Ventral protective membrane	wide with attenuated supports to tip of arm	wide with attenuated supports to tip of arm	present only on distal ⅓ of arm	wide with attenuated supports to tip of arm
Ventral sucker bases	modified as thin papillae	modified as thin papillae	rapidly diminish in height distally	rapidly diminish in height distally
Dorsal sucker bases	modified as broad based papillae extending to tip of arm equal in length to ventral papillae	modified as broad based papillae extending to tip of arm equal in length to ventral papillae	modified as distally flattened papillae extending to tip of arm	modified as broad based papillae extending to tip of arm

† Synthesis of values from Wormuth (1976) and material examined for this study.
* Synthesis of values from Kawakami and Okutani (1981) and material examined for this study.

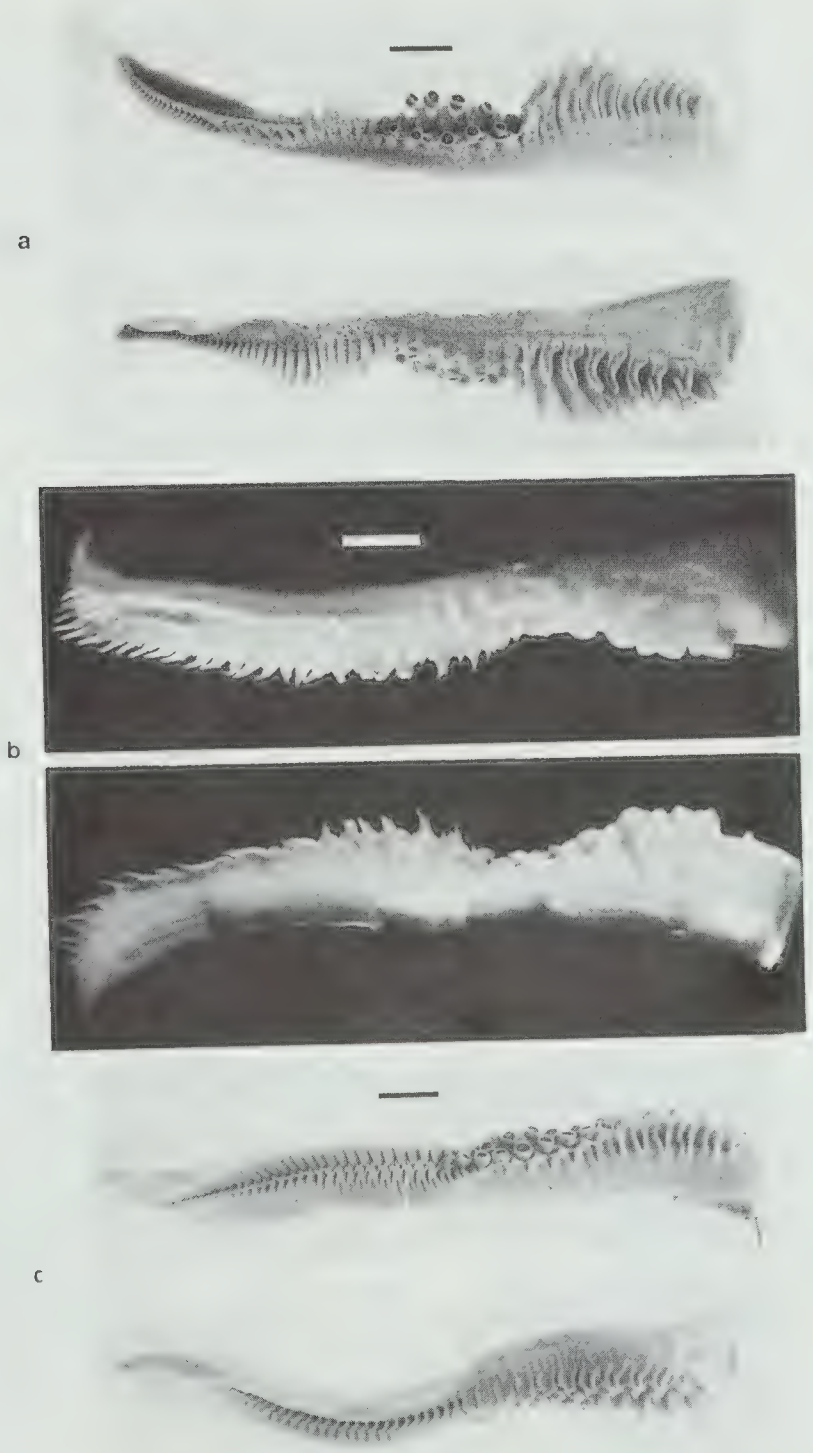

Figure 3. Right hectocotylized arms of a 256 mm ML male *Nototodarus sloani* from Taranaki Bight, central New Zealand (a), a 210 mm ML male *Nototodarus hawaiiensis* from off the northern Queensland coast (b) and a 266 mm ML male *Nototodarus gouldi* from off eastern Tasmania (c). Left ventral arms show a mirror reflection of the modified sucker bases seen on the proximal portion of the right arms in all species. (Scale = 10 mm)

preserved specimens of both *N. gouldi* and *N. sloani*, and represents a useful feature for rapid field identification. Regularly spaced thickenings in the dermis produce this "rough" texture.

On the basis of the size, number and dentition of arm and tentacular suckers (Figure 4), the structure of the hectocotylus in males and the "rough" texture of the skin, the northern Australian specimens are assigned to *N. hawaiiensis* (Berry, 1912).

Sexual dimorphism

While making measurements of the Australian *N. hawaiiensis* for the above morphometric comparisons, it became apparent that this species exhibits pronounced sexual dimorphism in body characteristics in larger specimens. A preliminary comparison of selected characters was undertaken for 25 males and 25 females between 120 and 231 mm ML trawled off the Great Barrier Reef in November 1985.

Larger head and arms, particularly of mature males are confirmed by significant differences in mean AIII length and head length indices (males: 66.9, 26.8 and females: 60.9, 23.7). No differences between males and females were found in fin proportions. (Mean fin length and fin width indices—males: 36.9, 60.6; females: 37.5, 61.1) [Mann-Whitney U-tests $p \geq 0.05$ (Siegel, 1956)].

Distribution and life history

The largest individuals of *N. hawaiiensis* examined were a fully mature female, 248 mm ML taken by demersal trawl in 376 m off the North-west Shelf in August 1982 and a mature male of 215 mm ML caught in 555 m off southern Queensland in May 1983. A 36 mm ML juvenile taken at night in a scoop net off Lady Elliot Island, southern Queensland in April 1981 was the smallest specimen examined. Off the north-western coast, this species was collected south to 19°20′S in depths of between 200 and 500 m in water temperatures of less than 12.4°C and off the east coast to 32°34′S in depths of 100 to 600 m.

Nototodarus hawaiiensis has been taken around Hawaii in shrimp trawls and occasionally on jigs over depths of from 230 to 710 m (Young, 1978; R. Harman, pers. comm.) and Dong (1963) examined specimens of up to 140 mm ML caught at a depth of 290 m off Hainan. The holotype of *N. sloani philippinensis* was trawled in 565 m in soft mud where the bottom temperature was 7.4°C (Voss, 1963). Around Hong Kong, *N. philippinensis* has been caught on the bottom in depths of 275 to 650 m, reaching a maximum size of 180 mm ML (Voss and Williamson, 1971).

Among Australian specimens of *N. hawaiiensis*, the smallest mature female was 154 mm ML and the smallest mature male 152 mm ML. Mature squid were present off both the north-west and north-east coasts at all times when samples were collected (Appendix 1) which, together with the broad size range of specimens in all samples indicates a prolonged spawning period in Australian waters. No significant size disparity was observed

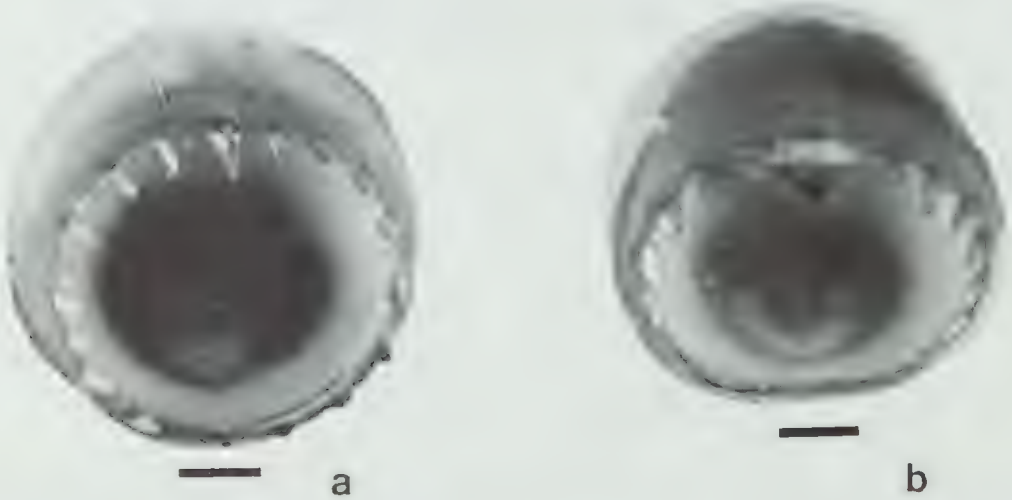

Figure 4. Arm III(a) and tentacular (b) suckers of a 205 mm female *Nototodarus hawaiiensis* from off northern Queensland. (Scale = 1 mm)

between females and males with an almost equal sex ratio evident in large samples (North-west Shelf, February 1983—60 females: 68 males; January 1984—314 females: 301 males).

In Hawaiian waters, male *N. hawaiiensis* reach maturity at less than 120 mm ML and females at less than 150 mm ML. Squid larger than 160 mm ML have not been reported in the literature from Hawaiian waters. Larvae of this species are present throughout the summer months (Harman and Young, 1986).

Off the eastern Australian coast between 28°S and 32°S, *N. hawaiiensis* and *N. gouldi* have been occasionally caught together on the upper continental slope and off the northern Queensland coast, the former species has been caught together with small numbers of *T. pacificus pusillus* (Dunning, 1988). The latter two species however are more abundant in shallower shelf waters. The distributions of *Todaropsis eblanae* (Ball, 1841) (Lu, 1982) and *N. hawaiiensis* show a major overlap in tropical Australian slope waters with *N. hawaiiensis* more abundant in all mixed samples I have examined.

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Loans of the type specimens of *N. sloani philippinensis* and the holotype and additional specimens of *N. hawaiiensis* were kindly arranged by M. Sweeney, U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. R. Harman, University of Hawaii, and S. Machida, Japan Marine Fishery Resource Research Centre, Tokyo, kindly provided comparative material of *N. hawaiiensis* and *N. sloani* respectively.

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Appendix 1. Details of *Nototodarus* material examined. For each lot data for vessel, cruise number, date, latitude, longitude, depth range, size range in mm, museum and registration number are given in that order. Locations of material are as follows: NMV, Museum of Victoria, Melbourne; QM, Queensland Museum, Brisbane; AM, The Australian Museum, Sydney. For samples marked * only representative material was examined.

Northern Australian *Nototodarus*

"Soela", 2/82, Apr 1982, 18°-18°20′S, 118°20′E, 298-404 m, 83-157, NMV F51639*

"Soela", 4/82, Aug 1982, 18°-18°46′S, 117°-118°30′E, 368-400 m, 53-248, QM Mo16363-4*

"Soela", 1/83, Feb 1983, 17°41′S, 119°02′E, 318-360 m, 66-161, QM Mo16367*

"Soela", 2/83, Apr 1983, 18°30′-45′S, 117°19′-37′E, 340-400 m, 56-197,NMV F52539*

"Soela", 1/84 Jan-Feb, 1984, 13°17′-19°15′S, 115°38′-120°33′E, 224-600 m, 44-218, NMV F52541*

"Soela", 5/85, Nov-Dec 1985, 17°10′-23°13′S, 146°40′-154°25′E, 162-646 m, 55-231, NMV F52533-34*

"Iron Summer", Nov 1982-Jun 1983, 27°10′-27°20′S, 153°50-154°E, 180-600 m, 135-238, QM Mo16361-2*

"Hoyo-maru", Apr 1981, 23°58′S, 152°42′E, 120 m, 36, NMV F52531

"Craigmin", Nov 1980, 23°33′-26°S, 152°43′-153°53′E, 300-320 m, 79-157, NMV F52532*

"Kapala", Mar 1977, 37°25′S, 150°15′E, 329 m, 106, AMC 140403

"Kapala", Mar 1978, 32°34′S, 152°49′E, ~250 m, 77-85, AM C119659

"Kapala", Aug 1978, 29°32′S, 153°48′E, 410 m, 177-182, AM C137098

"Kapala", Feb 1979, 11°35′S, 144°02′E, 275 m, 94-102, AM C137097

"Kapala", Jul 1982, 29°54′S, 153°39′E, 274 m, 142, AM C135502

Nototodarus hawaiiensis

"Hokusei-maru", 7 Feb 1983, Off Hilo, Hawaiian Islands, depth not known, 116-156, NMV F52554

Nototodarus sloani

"Ryoun-maru", 18 Jan 1983, 39°56′S, 172°422′E, depth not known 256, NMV F52537

Nototodarus gouldi

"Hoyo-maru", 6 Apr 1981, 41°07′S, 148°29′E, 100 m, 266, QM Mo16368

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A GENERIC REVIEW OF THE HYSSURIDAE (CRUSTACEA: ISOPODA) WITH A NEW GENUS AND NEW SPECIES FROM AUSTRALIA

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Abstract

Poore, G.C.B. and Lew Ton, H.M. 1988. A generic review of the Hyssuridae (Crustacea: Isopoda) with a new genus and new species from Australia. *Memoirs of the Museum of Victoria* 49: 169-193.

The isopod family Hyssuridae Wägele is confined to five genera: *Belura* gen. nov., *Hyssura* Barnard, *Kupellonura* Barnard, *Neohyssura* Amar and *Xenanthura* Barnard. *Ocsanthura* Kensley is synonymised with *Hyssura*, and *Kensleyanthura* and *Belizanthura* Kensley are synonymised with *Kupellonura*. The relationships between the genera are discussed.

Eight new species are described: *B. pillara, K. biriwa, K. currawan, K. gidgee, K. marrongie, K. werawera, N. bilara* and *X. ulawa;* and a key to separate the five genera and the Australian species is presented.

Introduction

The Hyssuridae is a family of primitive anthuridean Isopoda first separated from the Anthuridae and Paranthuridae, the other two families of the infraorder, by Wägele (1981a). Members of the family are distinguished from other anthurideans by the absence of a telsonic statocyst, free pleonites, non-operculiform first pleopods (all pleopods are similar) and small size. In this contribution Wägele's (1981a, b) original concept of the Hyssuridae is confined (only four of the original ten genera are recognised as being valid) and a new genus is added. The systematics of the Hyssuridae and the relationships of the genera are discussed. A key to the five genera and to the Australian species is presented. Each genus is diagnosed and eight new species in four genera from Australia are described.

Abbreviations used in figures are: A1, A2, antennae 1 and 2; E, pleonal epimera; MD, mandible; MP, maxilliped; MX1, maxilla 1; P1-P7, pereopods 1 to 7; PL1-PL5, pleopods 1 to 5; T, telson; UN, uropodal endopod (or endopod fused to peduncle); UX, uropodal exopod (flattened); l, left; r, right. On pleopods and male antennae 1 only representative setae or aesthetascs are drawn. Unless noted otherwise figures are of left limbs. The letters a, b, c, refer to separate figured individuals.

The Greek prefixes *hyssos* and *belos* mean javelin or spear and allude to the shape of the tail of species of the type genus. The specific epithets chosen for new species are Australian aboriginal words meaning spear and are nouns in apposition.

Material is lodged in the Museum of Victoria, Melbourne (NMV), Australian Museum, Sydney (AM), Queensland Museum, Brisbane (QM), and National Museum of Natural History, Washington (USNM). The station number prefixes for samples from Western Port, Bass Strait, and others from tropical Australia are taken from the Museum of Victoria's "station" data-base.

Systematics of the Hyssuridae

Wägele (1981a: fig. 30; 1981b) listed ten genera belonging to the Hyssuridae. The family was defined on the basis of two apomorphies: the body being very slender and the mouthparts of adult males being partly reduced. Our dissections of males show little evidence of mouthpart reduction. The genera were separated from the remaining two families of the Anthuridea (Anthuridae and Paranthuridae) whose synapomorphies were said to be the presence of telsonic statocysts and operculiform first pleopods.

Wägele's (1981a) cladistic analysis divided the genera into two groups, A and E. The four genera of genus-group E (*Rhiganthura* Kensley, *Stellanthura* Wägele, *Heptanthura* Kensley and *Eisothistos* Haswell) were defined on the basis of several synapomorphies. At least three of these characters clearly separate the genera from group A and align them with the non-hyssurid Anthuridea: long uropodal peduncle; sexually dimorphic pleon; and enlarged first pleopod. More importantly, these genera share shortened pleonites and the absence of a

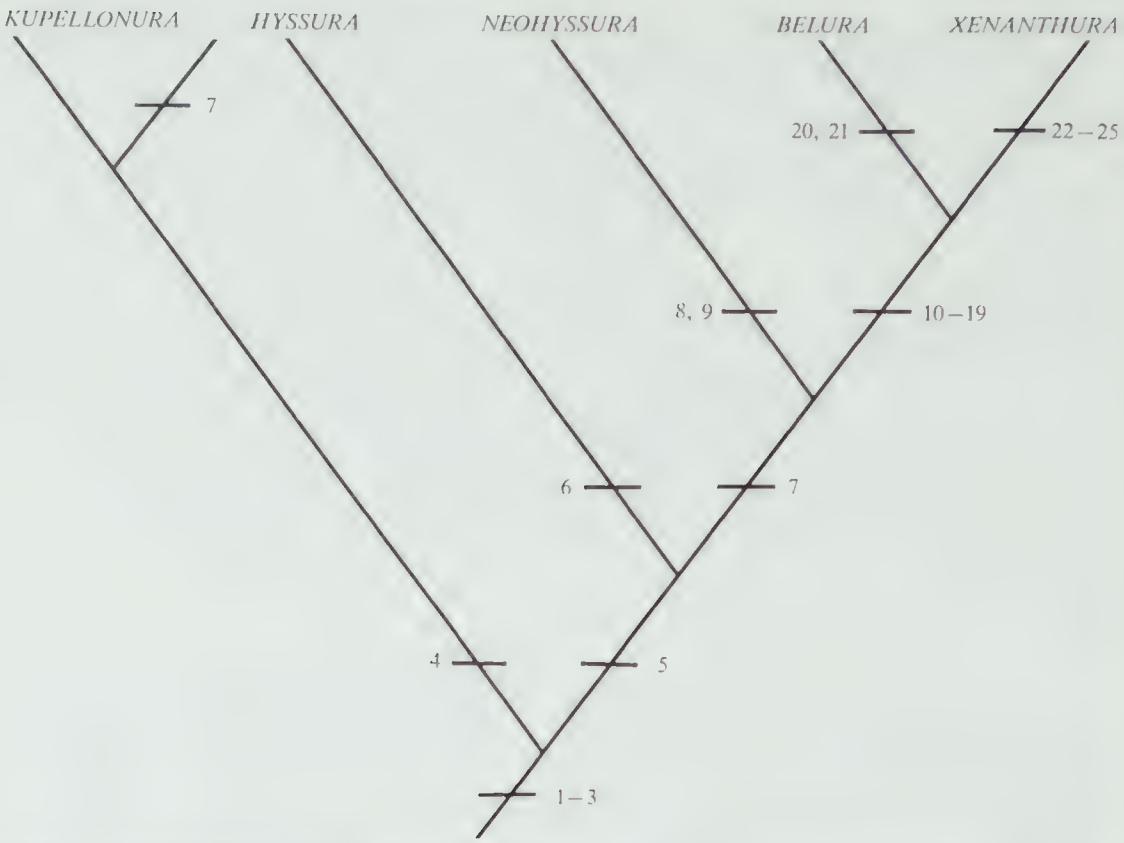

Figure 1. Cladogram depicting relationships between the five genera of the Hyssuridae. Apomorphies of the family and of each clade and genus are numbered and explained below. The character state in brackets is the plesiomorphic state.

1. Body small and slender (larger and wider).
2. Pereopods 2 and 3 subchelate and with carpus produced posterodistally (similar to pereopods 4-7).
3. Antenna 1 flagellum of 4 articles with aesthetases on second and last articles (several articles with at least 1 aesthetase on all articles except the first and last).
4. Uropodal exopod with a lateral lobe (no lobe).
5. Mandibular molar process acute (blunt).
6. Pereopods 4-7 with carpus rectangular (triangular).
7. Antenna 1 with 1 aesthetase on last article only (1 aesthetase on second and last articles).
8. Telson evenly tapering (more or less parallel-sided).
9. Telson and uropodal exopod with lateral spines (no spines).
10. Antenna 1 flagellum of 3 articles, first elongate, (4 articles of similar lengths).
11. Antenna 2 flagellum of 6 or fewer articles (8 or more articles).
12. Antenna 2 peduncle with a specialised plumose seta with a swollen base (no such seta).
13. Mandibular molar process an articulating toothed spine (simple non-articulating process).
14. Mandibular palp a single article (3 articles).
15. Maxillipedal palp articles fused (free).
16. Pleopodal endopods with 1 plumose seta (4 or more setae).
17. Uropodal endopod fused to peduncle (free).
18. Uropodal exopod medially expanded (not expanded).
19. Telson shortened (about as long as uropodal endopod).
20. Telson with an apical spine (no spine).
21. Pereopod 3 carpus with an acute posterodistal projection (carpus more rounded).
22. Pereopod 3 merus and carpus with a posterior brush of long setae (few setae).
23. Male with tri-partite eye (simple enlarged eye).
24. Male appendix masculina with apical spines (no spines).
25. Pleopods 2-5 of male of 1 article (2 articles).

produced carpus on pereopods 2 and 3 with the Anthuridae and Paranthuridae. The only synapomorphies of group E which are unique are a broadened tail fan and a strong projection on the uropodal exopod. For these reasons we exclude these genera from the Hyssuridae believing them to be more closely allied to the Anthuridae s.s.

The Hyssuridae, therefore, in the sense used in this contribution comprises only those genera included in Wägele's genus-group A.

The family is diagnosed largely on the basis of numerous plesiomorphies but there are undisputed apomorphies of which small size and slender form are two. Wägele defined genus-group A on characters M.1 and M.2 (1981a, fig. 30) as follows:

Pereopods 2 and 3 are subchelate. This is a probable apomorphy if a similar condition in the Paranthuridae is independantly derived.

The carpus of pereopods 2 and 3 is posterodistally produced. Similar structures are not seen elsewhere in other anthuridean families.

The flagellum of antenna 1 has at most four articles with one aesthetasc on the terminal article and primitively one on the second. This condition is not seen elsewhere and is a unique apomorphic state derived from a longer flagellum with at least one aesthetasc on every article except the first and the last (Wägele, 1981, 1983). In other Anthuridea the terminal aesthetasc-free article may also be lost and the last of the remaining articles may carry more than one aesthetasc.

The apomorphies of the family are summarised in Fig. 1.

Two of the six genera of genus-group A listed by Wägele, *Ocsanthura* Kensley and *Kensleyanthura* Wägele, are reduced to junior synonyms. The family now includes *Hyssura* Barnard, *Kupellonura* Barnard, *Neohyssura* Amar, *Xenanthura* Barnard and the new genus *Belura*.

Our intuitive interpretation of the phylogeny of the five genera differs from that hypothesised by Wägele (1981a: 69-72, fig. 30). The relationships be-

Key to World genera and Australian species of Hyssuridae

1. Uropodal exopod as broad or broader than long, endopod fused to peduncle; pleopodal endopods with single apical seta; mandibular palp of 1 article with seta 2
– Uropodal exopod longer than wide, endopod free; pleopodal endopods with several marginal setae; mandibular palp of 3 articles 3
2. Pereopod 3 merus and carpus with tufts of long setae; telson short, excavate apically; eyes present ..... *Xenanthura*
..... one Australian species *X. ulawa*
– Pereopod 3 merus and carpus acutely produced posterodistally; telson with apical projection; eyes absent ..... *Belura*
..... one Australian species *B. pillara*
3. Uropodal exopod linear, its medial margin and lateral margins of telson with cuticular spines ..... *Neohyssura*
..... one Australian species *N. bilara*
– Uropodal exopod linear or with lateral lobe, unarmed; telson unarmed 4
4. Pereopod 2 propodus palm oblique; pereopods 4-7 with carpus quadrangular, with 2 marginal spines; molar acute ..... *Hyssura*
..... (not known from Australia)
– Pereopod 2 propodus palm axial; pereopods 4-7 with carpus triangular, with 1 marginal spine; molar blunt ..... *Kupellonura* . . . 5
5. Uropodal exopod linear (about 3 times as long as wide) ..... *K. marrongie*
– Uropodal exopod laterally lobed (little more than twice as long as wide) 6
6. Lateral margins near base of telson and uropodal endopod, and mesial margin of base of uropodal exopod each with 2 recurved hooks ..... *K. currawan*
– Margins not so armed, dentate at most 7
7. Uropodal exopod with lateral lobe proximal; apex of telson evenly tapering over distal third ..... *K. gidgee*
..... Uropodal exopod with lateral lobe widest at midpoint; apex of telson broadly rounded 8
8. Telson apex rounded, apex weakly produced (temperate) ..... *K. birawa*
– Telson apex rounded-truncate with definite apical setiferous protuberance (tropical) ..... *K. werawera*

tween them and the apomorphies defining each monophyletic group and genus are given in fig. 1. With the exception of the synapomorphies of *Belura* and *Xenanthura* (characters 10-19) those characterising the other genus-groups are not strong. But only one homeoplasy is seen: *some* species of *Kupellonura* share with *Xenanthura, Belura* and *Neohyssura* the loss of one aesthetasc (character 7).

Hyssuridae Wägele

Hyssuridae (genus-group A) Wägele, 1981a: 68.—1981b: 48.

Diagnosis. Pleon elongate (about as long as pereonites 6 and 7); pleonites free, little wider than long.

Antenna 1 flagellum of 3-4 articles, with 1 aesthetasc on last article and sometimes on article 2. Antenna 2 flagellum of 5-9 articles. Mouthparts compact, not piercing. Mandibular molar process an acute spine, blunt or reduced; palp of 1 or 3 articles. Maxilliped narrow; endite short or reaching to second palp article; palp of 5 free articles or single article.

Pereopods 1-3 subchelate, pereopod 2 as large as 1 or larger; basis linear, carpus posterodistally produced. Pereopods 4-7 carpus triangular (rectangular in *Hyssura*); with 0-2 posterior carpal spines and 0-2 posterior propodal spines. Pleopods 1-5 of equal length; pleopod 1 not operculiform. Uropodal peduncle short (about one-third of total length); exopod attached basally.

Telsonic statocysts absent.

Male antenna 1 flagellum of 4-12 isometric aesthetasc-bearing articles.

Belura gen. nov.

Diagnosis. Antenna 1 of 3 articles, with 1 aesthetasc on terminal article. Antenna 2 peduncle with plumose setae distally (in addition to typical brush setae) of which most ventral has swollen base. Mandibular molar process an articulating toothed spine; palp a single article with terminal seta. Maxillipedal endite short; palp of fused articles.

Pereopod 2 palm almost transverse, carpus barely produced. Pereopod 3 dactylus, carpus and merus all acute distally. Pereopods 4-7 carpus triangular, very short or without anterior margin, without posterior carpal and propodal spines. Pleopodal endopods triangular, with terminal seta; exopods ovoid, setose. Uropodal endopod fused to peduncle; exopod ovoid. Telson shorter than uropods, with strong apical projection.

Type species. Belura pillara sp. nov.

Etymology. From the Greek *belos* (dart) and *ura* (tail) alluding to the shape of the apex of the telson (feminine).

Remarks. The new genus *Belura* is very similar to *Xenanthura* Barnard with which it shares similarities in the structure of antennae 1 and 2, pereopods 4-7, pleopods and uropods. The most obvious differences are in the presence of eyes, structure of pereopod 3 and the telson. The lamina dentata and male appendix masculina also differ. The male antenna 1 of *Belura* is shorter than that of *Xenanthura* but males of few species are known.

The south-western Atlantic species, *B. acuticauda* (George and Negoescu) comb. nov. should be removed from *Xenanthura* to the new genus. In doing so, *Belura* is then confined to two species from cool temperate waters while the remaining six species of *Xenanthura* are more tropical (George and Negoescu, 1985).

Belura pillara sp. nov.

Figures 2—4

Material examined. 48 juveniles, 6 mancas, 1 male; to 3.5 mm.

Holotype: Bass Strait, 75 km S of Wilsons Promontory, (39°49.5'S, 146°18.5'E), 82 m, shell-bryozoan mud, Smith-McIntyre grab, G.C.B. Poore et al. on RV "Tangaroa", 13 Nov 1981 (stn BSS-158), NMV J15001, juvenile, 3.5 mm (with 2 slides).

Paratypes: Type locality. NMV J15002 (male, with 2 slides), NMV J15003 (10 juveniles, with 1 slide) J15004 (3 mancas), AM P37926 (5 juveniles), USNM 211448 (5 juveniles).

Other material: Bass Strait. Type locality (epibenthic sled sample), NMV J15005 (2); Eastern slope (39°28.2'S, 148°52.4'), 841 m, muddy sand, naturalist's, dredge, G.C.B. Poore on HMAS "Kimbla", 29 Mar 1979 (stn BSS-37), NMV J15006 (1 post-manca). S of Point Hicks (38°17.7'S, 149°11.3'E), 400 m, coarse sand and gravel, epibenthic sled, M. Gomon et al. on RV "Franklin", 24 Jul 1986 (stn SLOPE-40), NMV J14466 (2). Eastern Gippsland (37°59'S, 148°27'E), 51 m, muddy sand (stn BSS-207), NMV J15007(9); (37°50'S, 148°40'E), 26 m, medium sand (stn BSS-208), NMV J15008(2)—both epibenthic sled, M. Gomon and R. Wilson on FV "Silver Gull", 30 Jul 1983.

Vic. Western Port, off Crib Point (38°21'S, 145°14'E), 10-19 m, sandy sediments, 1964-1972 (CPBS stations), NMV J15009-J15016 (10 specimens). Western Port, Western Entrance, 10-23 m, sandy sediments, 1974: stn WBES-1742, NMV J15017 (3); stn WBES-1748, J15018 (1)

Description. Body 18 times as long as wide, colourless. Head about as wide as long, without eyes. Antenna 1 articles 1, 2 and 3 with 1, 2, 0 brush-setae respectively; flagellum of 3 articles, first with brush-seta, last with 1 aesthetasc, 1 plumose seta, 1 sim-

Figure 2. *Belura pillara,* holotype (f, flagellum in lateral view; scale = 0.5 mm).

Figure 3. *Belura pillara,* holotype; b, paratype male, NMV J15002.

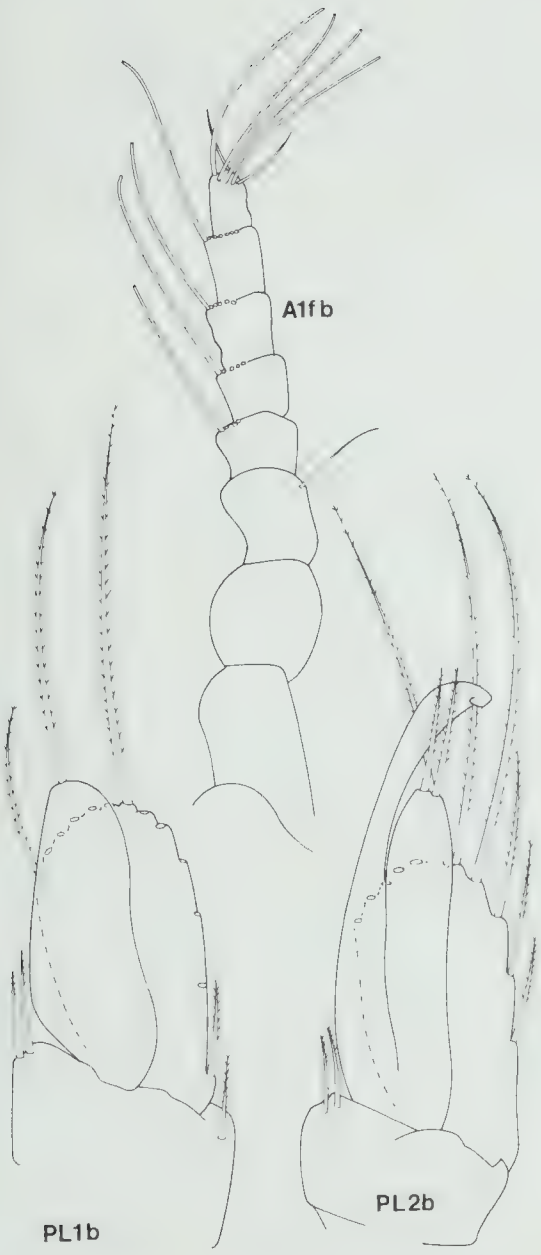

Figure 4. *Belura pillara,* holotype; b, paratype male, NMV J15002.

ple seta. Antenna 2 articles 4 and 5 with brush-setae, article 5 with ventral plumose setae of which base is swollen; flagellum of 8 articles.

Mandible with bluntly toothed incisor; lamina dentata of 3 finely denticulate plates, most distal with additional coarser teeth; molar process an articulating spine with row of fine denticles along its length and longer teeth at apex; palp a narrow article with long apical seta. Maxilla 1 with 7 apical setae. Maxilliped with short endite; palp a single plate with 1 mesial, 1 lateral and 4 distal setae.

Pereopod 1 carpus slightly produced posterodistally; propodus elongate, about 2.5 times as long as wide; palm axial with 2 proximal pectinate setae, 2 short simple setae, and 2 long and 1 short setae distally; 3 mesial setae. Pereopod 2 carpus slightly produced posterodistally; propodus almost twice as long as wide; palm oblique with pectinate setae, 2 short setae proximally, 1 short and 1 longer setae distally. Pereopod 3 merus and carpus acutely produced posterodistally; propodus almost twice as long as wide; palm oblique with pectinate setae, 2 short setae proximally, 1 short and 1 longer setae distally. Pereopod 3 merus and carpus acutely produced posterodistally; propodus 1.4 times as long as wide, palm straight. Pereopods 4-7 with few posterior setae; merus with digitiform denticles posteriorly; palm sinuous, unarmed; propodus of pereopods 5-7 with 2 distomesial spines.

Pleopod 1 peduncle with 2 setae on mesial lobe; endopod with 1 distal seta; exopod half length of endopod, with 13 marginal plumose setae. Pleopods 2-5 similar to first. Pleonal epimera 1-4 with 2 and epimeron 5 with 1 marginal plumose setae.

Uropodal peduncle and endopod fused, with broad ventromesial shelf bearing 3 large brush-setae in distal concavity; apex rounded, with 3 finer brush-setae and 10 simple setae; exopods overlapping, roughly semicircular, little longer than wide, with 8 setae distally. Telson not reaching to uropodal apices, widest proximally, narrowing gradually to 0.8 length, then abruptly narrower to apical spike, 2 apical setae.

Male. Antenna 1 flagellum of 5 articles each bearing about 6 aesthetascs. Pereopod 1 similar to juvenile except mesial propodal setae. Pereopod 2 carpus strongly produced posterodistally, with apical setae; palm more transverse. Pleopod 1 peduncle more rectangular; exopod almost as long as endopod. Pleopod 2 with narrow endopod with 2 apical spines; appendix masculina exceeding endopod, broad, apically curved. Pleopods 2-5 exopods of a single article.

Distribution. Victoria (Western Port only) and Bass Strait, coarse shelly sediments, 10-841 m.

Remarks. Belura pillara differs from *B. acuticauda* (George and Negoescu) from the South Atlantic, the only other species in the genus, in small ways. Pereopods 1 and 2, the pleopods and the telson are more elongate. The maxilliped bears a lateral seta not shown in *B. acuticuda* but this seta is usual in many anthurideans.

Hyssura Norman and Stebbing

Hyssura Norman and Stebbing, 1886: 128.—Barnard, 1925: 137.—Wagele, 1981a: 70-75, 103.—1981b: 49.

Ocsanthura Kensley, 1978: 558 (type species *Ocsanthura vimsae* Kensley, 1978) new synonym.

Oscanthura Kensley.—Wägele, 1981a: 70, 72, 74, 103.—1981b: 49 (lapsus calami).

Diagnosis. Antenna 1 flagellum of 4 articles with 1 aesthetasc on each of second and terminal articles. Antenna 2 peduncle without stout plumose setae. Mandibular molar process acute; palp of 3 articles. Maxillipedal endite reaching to second palp article, apex acute; palp of 5 free articles.

Pereopod 2 palm oblique, with marginal spines. Pereopods 4-7 carpus rectangular; with 1-2 posterior carpal spines and 1 posterior propodal spine. Pleopodal rami ovoid, setose. Uropodal exopod longer than wide. Telson evenly tapering.

Type species. Hyssura producta Norman and Stebbing, 1886 (monotypy).

Remarks. Five species are known, all from the Atlantic or Mediterranean; no species are recorded from Australia. Wägele (1981b) redescribed the type species from the only specimen known. He implied that this specimen is a manca and that the absence of a seventh pair of legs does not characterise the genus. Wägele's second species, *H. ligurica,* has seven pairs of pereopods. All three species of *Ocsanthura* must be removed to *Hyssura* since the only features supposed to distinguish the genus, presence of pereopod 7 and a statocyst, are not real. Our examination of type material of *H. vimsae* (Kensley) comb. nov., type species of *Ocsanthura,* has shown that contrary to the original diagnosis no statocysts are present. In this the species agrees with *H. bacescui* (George and Negoescu) comb. nov. and probably *H. gracilis* (Kensley) comb. nov.

The genus *Hyssura* retains the most plesiomorphies of any anthuridean. Its apomorphy is the enlargement of the carpus of pereopods 4-7. Its species are most similar to those of *Kupellonura* which differ in the presence of a laterally-lobed uropodal exopod.

Kupellonura Barnard

Kupellonura Barnard, 1925: 146.—Wägele, 1981a: 71-75.—1981b: 55.—Kensley, 1982a: 126.

Horoloanthura.—Kensley, 1975: 75 (partim) (not *Horolanthura* Menzies and Frankenberg, 1966).

Kensleyanthura Wägele, 1981a: 106.—1981b: 82 (type species *Kupellonura capensis* Kensley, 1975) new synonym.

Belizanthura Kensley, 1982b: 338 (type species *Belizanthura imswae* Kensley, 1982).

Diagnosis. Antenna 1 flagellum of 4 articles, with 1 aesthetasc on terminal article and sometimes 1 on second article. Antenna 2 peduncle without stout plumose setae. Mandibular molar process a simple blunt tooth; palp 3-articled. Maxilliped with endite reaching third palp article; palp of 5 articles.

Pereopods 2 and 3 palm axial, with marginal spines. Pereopods 4-7 carpus triangular, carpus and propodus each with 1 posterodistal spine. Pleopodal rami both with several marginal setae. Uropodal endopod free, longer than peduncle; exopod foliar or narrow. Telson spatulate, about as long as uropods.

Type species. Kupellonura mediterranea Barnard, 1925 (monotypy).

Remarks. The complex synonymy of *Kupellonura* has been discussed by Kensley (1982a) and Negoescu and Wägele (1984). Eight species are known from the Atlantic, Mediterranean, New Zealand and Caribbean (Negoescu and Wägele, 1984; Wägele, 1985; George and Negoescu, 1985).

The genus is most easily recognised by the uropodal exopods, held obliquely erect in preserved material and usually with a lateral lobe. The first species, *K. birawa,* is figured and described in detail. The general form, number of articles and setation of the antennae, shape and setation of the pereopods and pleopods, and mouthparts of all other species were examined in detail but only the telson and uropods which are diagnostic are consistently figured. Differences in setation or proportions are noted and figured only where they are significantly different from *K. biriwa.*

In all Australian species the flagellum of antenna 1 has only one aesthetasc (on the terminal article). This condition is shared with *K. formosa* (Menzies and Frankenberg) and *K. racovitzai* George and Negoescu. All other species have two aesthetascs (George and Negoescu, 1985, and literature cited therein).

The male of *K. gidgee* is figured. The aesthetasc-bearing flagellum of antenna 1 is of 5 articles in this and other species. The male has larger eyes and lacks the pleonal epimeral setae found on juveniles.

Uropodal rami and the telson are narrower than in juveniles.

Species of *Kupellonura* are unusual in the possession of a tessellated cuticle on the dorsal surface of the antennal peduncles, head and pereonite 1. A mosaic of small tessae is visible under Nomarski illumunation at 400 times (Fig. 10). The fact that it has not been reported elsewhere in the Anthuridea may reflect the techniques used for examination more than reality.

Kupellonura biriwa sp. nov.

Figures 5—8

Material examined. 9 juveniles, 1 manca, 2 males; to 4.5 mm.

Holotype: Victoria, Western Port, exact locality not recorded (38°S, 145°E), Marine Studies Group, early 1970s, NMV J15019, juvenile, 4.5 mm (with 2 slides).

Paratypes: Vic., type locality, NMV J15020 (3 juveniles). Western Port, 38°29.78'S, 145°06.28'E) sand, 24 m, 25 Nov 1974 (stn WBES-1746), NMV J15021 (male, 3.1 mm, with 2 slides); J15022 (1 juvenile); off Sandy Point, French Is. (38°21.6'S, 145°30.6'E), sand, 9 m, 26 Nov 1973 (stn WBES-1735), J15023 (manca, 2.3 mm); Crib Point (38°21'S, 145S°14'E), sand, 9-13 m, 1964-1965—stn CPBS-A4, J15024 (1 juvenile); stn CPBS-23S, J15025 (1 juvenile); stn CPBS-33S, J15026 (1 male).

Other material examined. NSW, Hawkesbury River, A. Jones, 1978, AM P29754 (with 2 slides), P29756, P29757 (3 specimens).

Description. Body 20 times as long as wide, colourless. Head longer than wide, acute rostrum, lateral eyes. Antenna 1 peduncle with few fine brush-setae; flagellum with short first article, second longer, plus 2 shorter, with terminal aesthetasc. Antenna 2 flagellum of 9 articles.

Mandible incisor bluntly toothed; lamina dentata finely denticulate proximally, with coarser teeth distally; molar process rounded; palp articles 1 and 2 each with 1 seta, last article recurved, with 3 setae. Maxilla 1 inner lobe with 1 terminal seta, outer lobe strongly curved, with 1 strong plus 3 finer apical teeth. Maxillipedal endite narrow, with 1-2 terminal setae; palps asymmetrical, articles 1-5 with 0, 1, 1 or 2, 1 or 2, and 4 setae respectively.

Pereopod 1 carpus slightly produced posterodistally, with marginal and subterminal spines; propodus 1.8 times as long as wide, palm with 2 marginal spines and blade-like setae on cutting edge, 3 mesial setae. Pereopod 2 carpus strongly produced posterodistally, with marginal and subterminal spines; propodus with 2 spines with accessory flagella and blade-like seta on cutting edge, 1 submarginal seta distally. Pereopod 3 similar to pereopod 2 but propodus smaller. Pereopods 4-7 carpus triangular, with short anterior margin, carpus and propodus each with posterodistal spine. Pleopod 1 peduncle short, rectangular; endopod longer than exopod, with 5 plumose setae; exopod with 11 plumose setae. Pleopods 2-5 similar to first. Pleonal epimera 1-4 with 5 submarginal plumose setae and 1 smaller simple seta; epimeron 5 with 1 plumose plus 2 simple setae.

Uropodal endopod about twice as long as peduncle, 1.8 times as long as wide, apex broadly rounded, with about 16 long setae. Exopods overlapping, as long as endopod and telson, 1.8 times as long as wide, widest at midpoint; mesial margin gently convex, dentate; lateral margin strongly convex; apex acute, with 10 setae. Telson basally narrow, 2.1 times as long as wide, concave dorsally and with broad ventral longitudinal ridge; lateral margins straight, denticulate distally; apex rounded over last third, with 12 apical setae.

Male. Head narrower than in juvenile, eyes large. Antenna 1 flagellum with 5 aesthetasc-bearing articles plus basal and terminal articles. Maxilliped similar but endite absent. Pereopod 1 propodus narrower, palm with 4 mesial and 5 marginal setae. Pleopods more elongate; pleopods 2-5 with 2-articulate exopods. Pleopod 2 with hooked appendix masculina.

Distribution. Victoria (Western Port) and New South Wales (Hawkesbury River), 9-24 m.

Remarks. Three specimens from the Hawkesbury River, NSW, differ slightly from the type material (fig. 8). The pereopods and uropods are narrower than in the Victorian material but the details of setation are identical. In view of the small number of specimens available these are not recognised as a separate species.

The species is confined to marine bays of southeastern Australia. A single specimen of *Kupellonura* from nearby Bass Strait (*Kupellonura* sp. herein) is considered a separate species.

The dentate margins of the telson and uropodal exopod are similar to those seen in *K. serritelson* Wägele.

Kupellonura currawan sp. nov.

Figure 9

Material examined. Unique.

Holotype: NSW, off Nowra (34°51.9'S, 151°12.6'E), crinoid dominated community, 777 m, G.C.B. Poore and C.C. Lu on RV "Franklin", 15 Jul 1986, epibenthic sled (stn SLOPE-6), NMV J14477, juvenile, 6.5 mm (with 2 slides).

Diagnosis. Antenna 1 with 1 aesthetasc. Uropodal endopod 2.5 times as long as wide, dorsolateral

Figure 5. *Kupellonura biriwa,* holotype (scale = 0.5 mm).

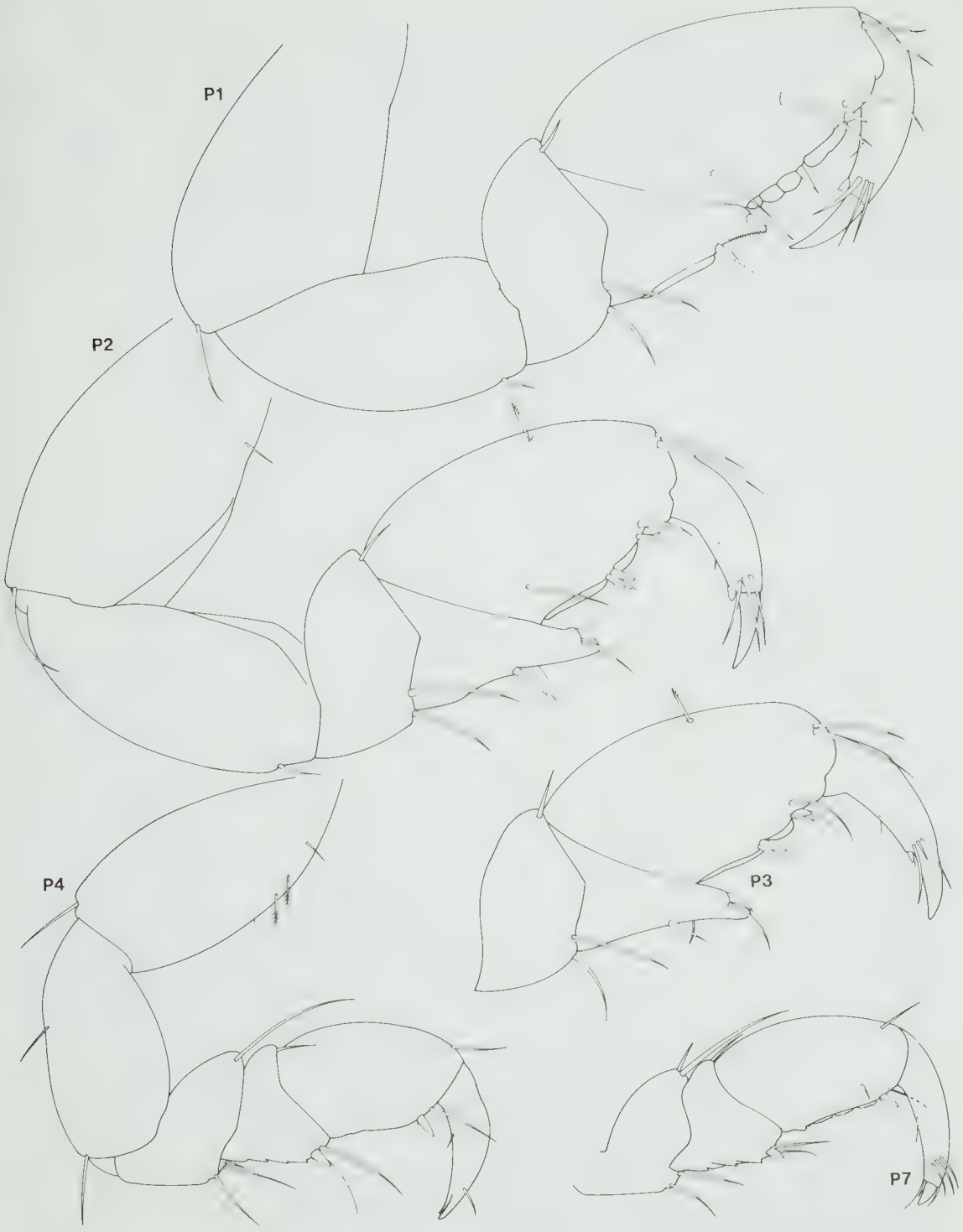

Figure 6. *Kupellonura biriwa,* holotype.

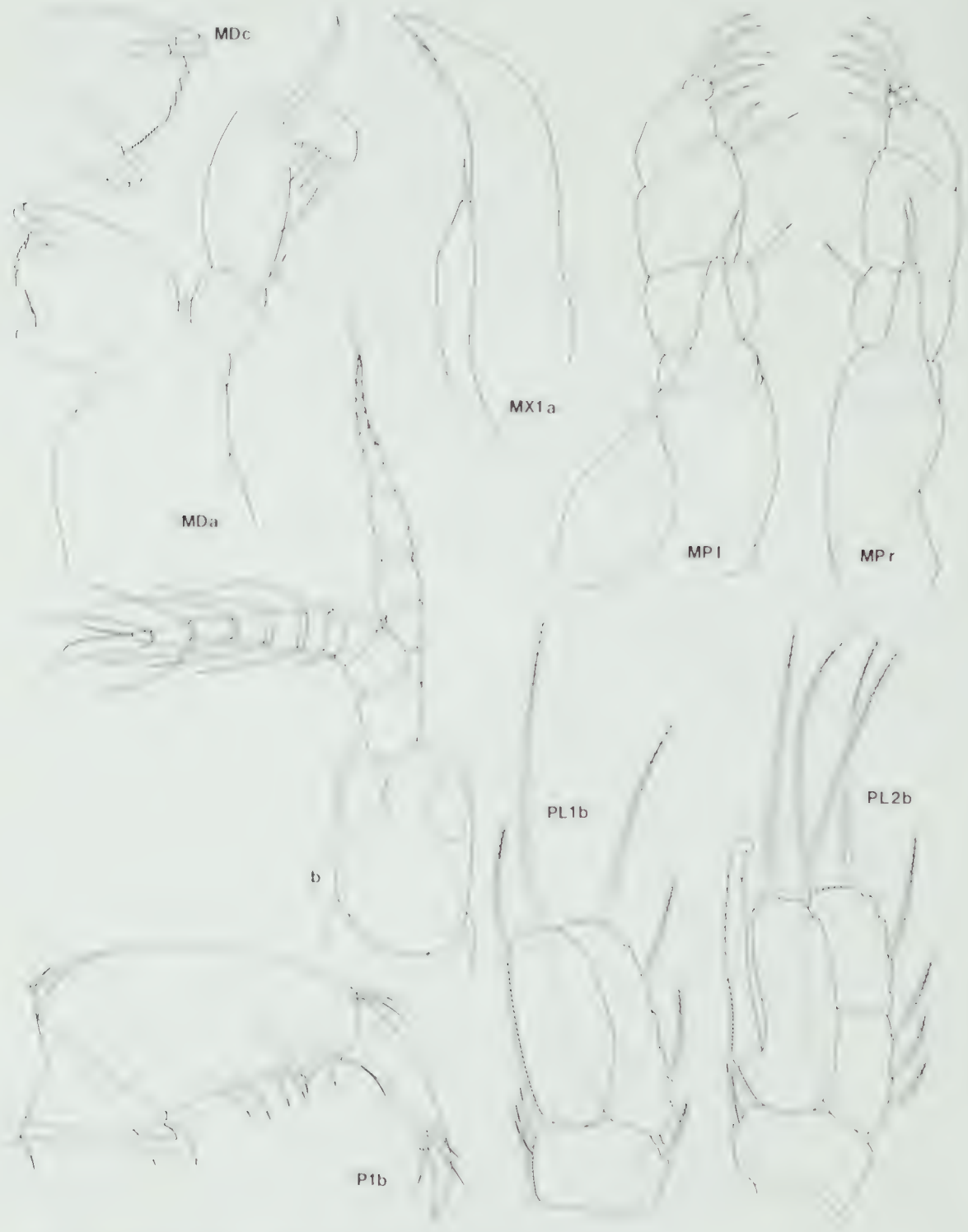

Figure 7. *Kupellonura biriwa*: a, holotype; b, paratype male, NMV J15021; c, juvenile, Hawkesbury River, AM P29754.

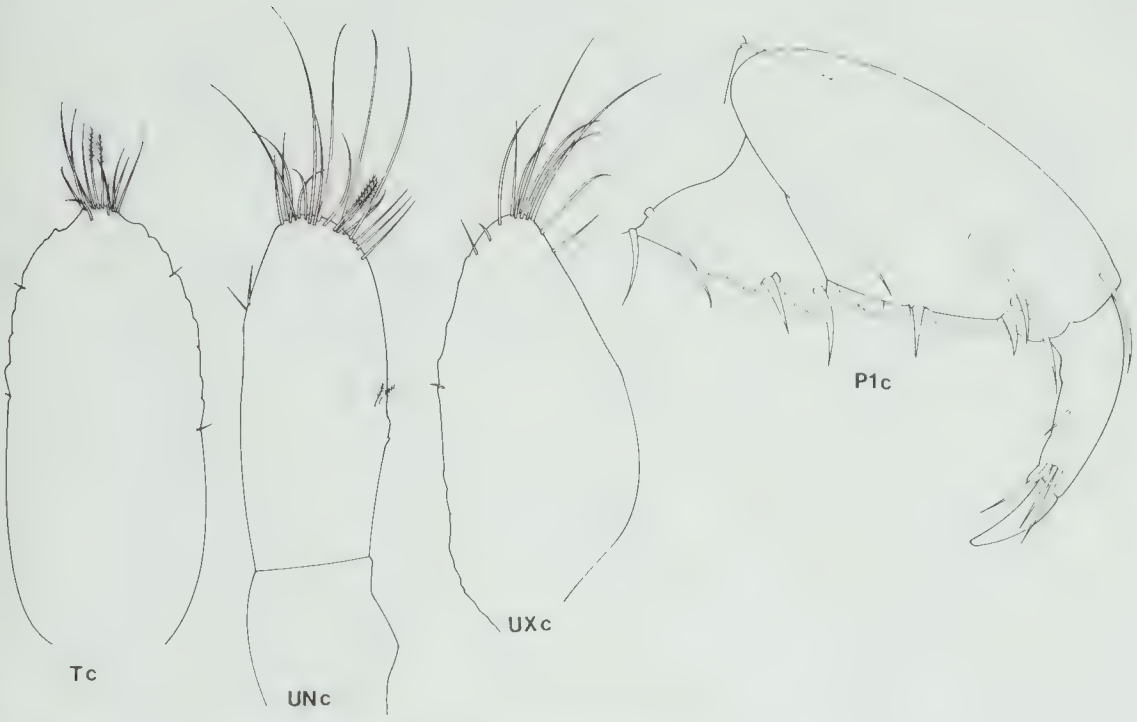

Figure 8. *Kupellonura biriwa*: c, juvenile, Hawkesbury River, AM P29754.

margin with proximal ridge bearing 2 recurved hooks; exopod not reaching as far as endopod or telson, 2.3 times as long as wide, laterally convex, medial margin with 2 recurved hooks proximally, dentate distally. Telson 3.2 times as long as wide, more or less parallel-sided, with narrowly rounded apex, with 2 pairs of recurved hooks proximally, dentate distally.

Distribution. New South Wales slope (known only from type locality).

Remarks. Kupellonura currawan differs from all other species in the genus in the presence of hooks on the margins of the telson and uropodal rami.

The pereopods are narrower than in *K. biriwa*, pereopods 1-3 have three marginal propodal spines rather than 2, and the endopod of the pleopods is more rectangular. The figure of maxilla 1 is drawn more flat than that shown for *K. biriwa*.

Kupellonura gidgee sp. nov.

Figure 10

Material examined. 10 juveniles, 2 males, 4 mancas; to 3.4 mm.

Holotype: Qld, Great Barrier Reef, Lizard Island (14°40′S, 145°28′E), B. Kensley, Jan 1982 (stn BK-113), NMV J15027, juvenile, 3.4 mm (with 2 slides).

Paratypes: Type locality, NMV J15028, male, 2.8 mm; J15029, 5 juveniles, 1 manca. Lizard Island, B. Kensley, Jan 1982 (stns BK-117, BK-127, BK-130), NMV J15030 (1 submale), J15031 (1), J15032 (1); (stn K-L5), USNM 211447 (2); (stn BK-129), QM colln(2). Lizard Is., Granite Head, 100 m offshore, coralline and other algae, 10 m, G.C.B. Poore, 11 Dec 1987 (stn NQ-125), NMV J14751(1 male).

Other material. Qld. Lizard Island, B. Kensley, Jan 1982 (stn BK-115) NMV J15033 (1 manca).

NT. West side of Oxley Island (11°00′S, 132°49′E), 14 m, J.K. Lowry, 21 Oct 1982 (stn NT-82), NTM colln.

Diagnosis. Antenna 1 with 1 aesthetasc. Uropodal endopod 2.1 times as long as wide; exopod not reaching as far as endopod or telson, 2.1 times as long as wide, widest at proximal third, mesial margin gently convex, lateral margin strongly convex proximally. Telson basally narrow, 2.5 times as long as wide, lateral margins convex, dentate distally, apex subacute.

Male. Pereopod 1 propodus with 4 marginal setae.

Distribution. Queensland, northern Great Barrier Reef, Northern Territory coral cays.

Remarks. Kupellonura gidgee differs from *K. biriwa* in having slightly broader pereopodal propodi but setation is identical. The shorter and proximally

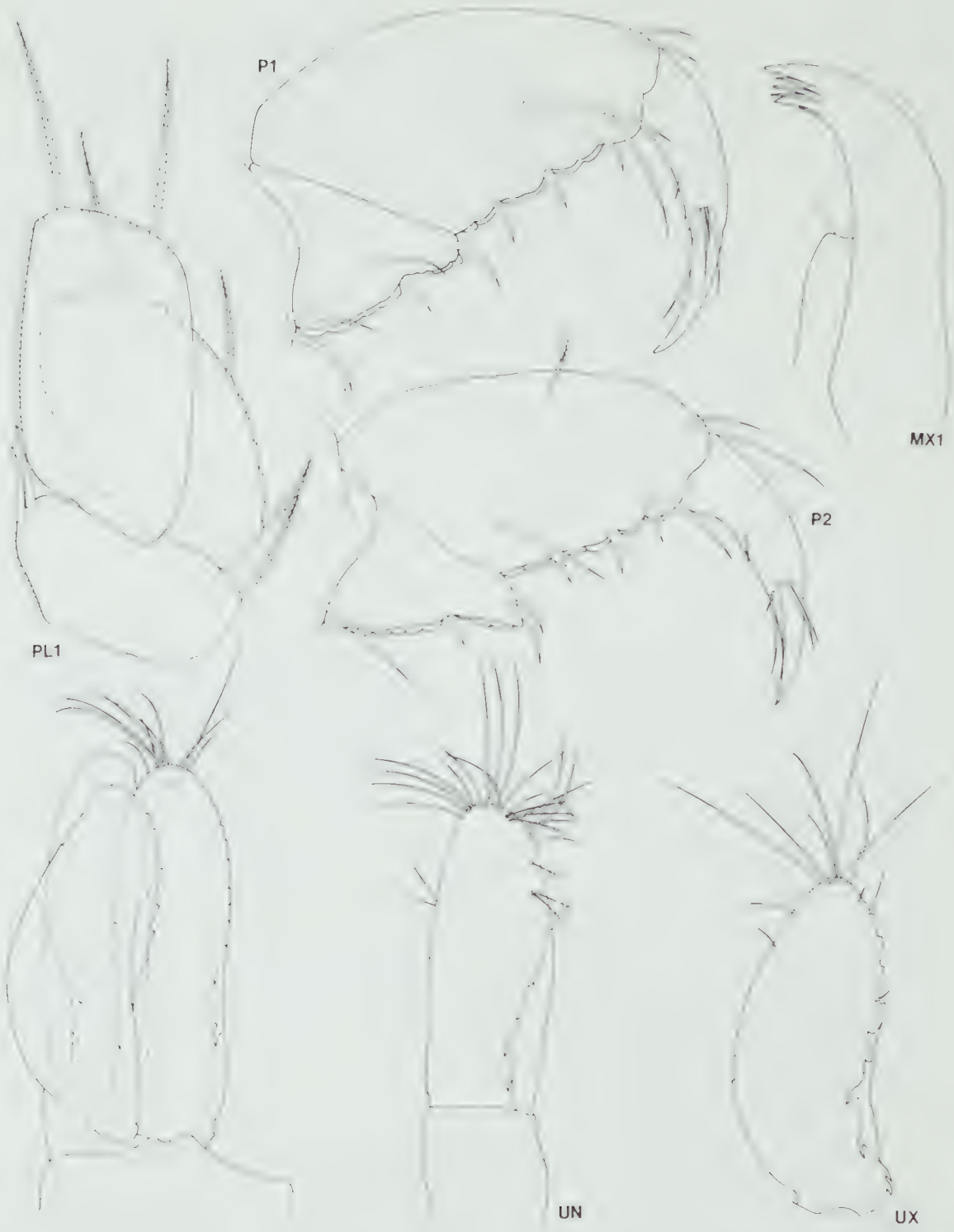

Figure 9. *Kupellonura currawan,* holotype.

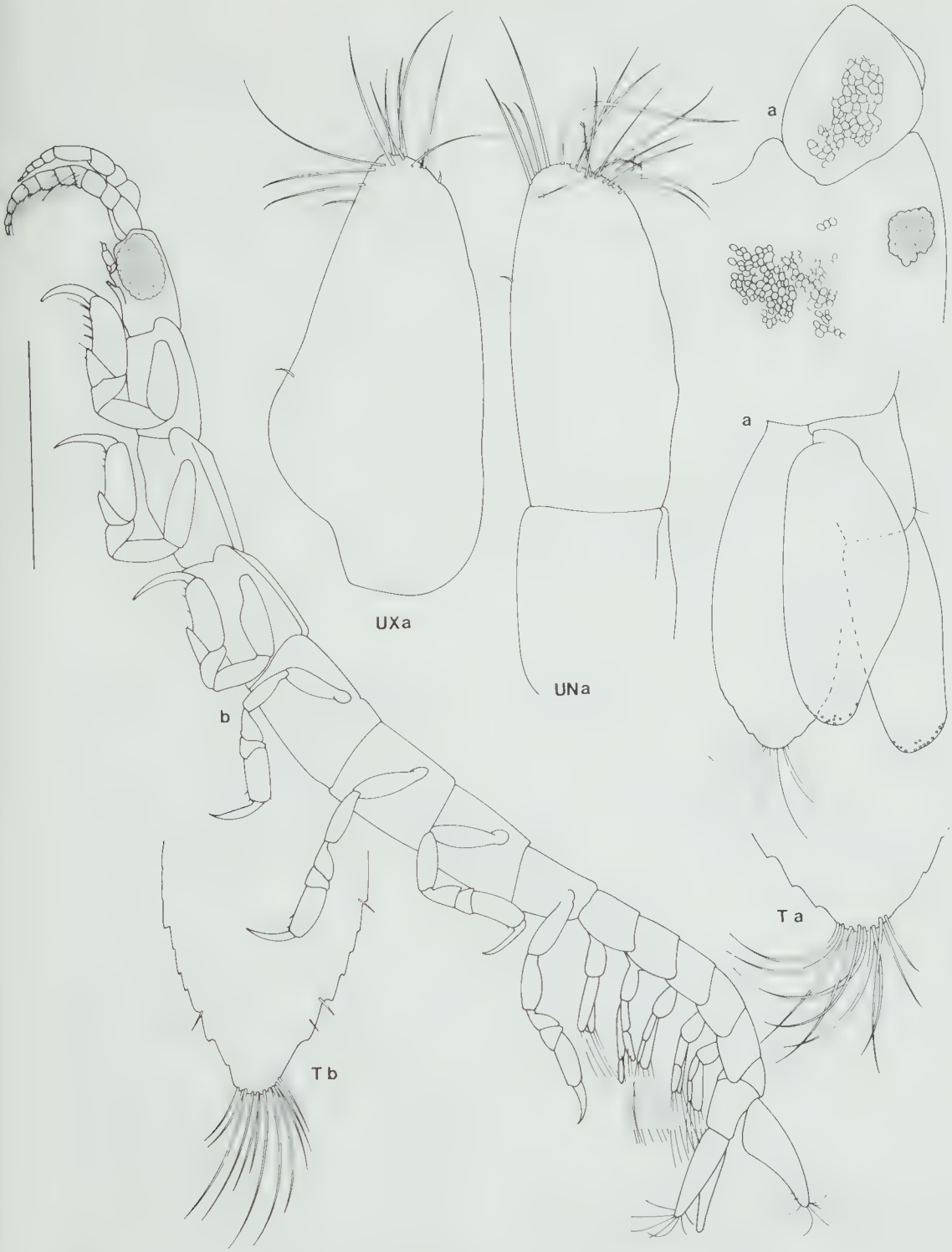

Figure 10. *Kupellonura gidgee*: a, holotype; b, paratype male, NMV J15029 (scale = 0.5 mm).

wider uropodal exopod is diagnostic. The male (fig. 10) displays the antenna 1, longer eyes and pleopods typical of the genus. The tessellated pattern on the integument of the head and antenna is shown in fig. 10.

The species co-occurs with *K. marrongie* at Lizard Island (even being taken in the same sample) but differs in its wider uropodal exopod.

Kupellonura marrongie sp. nov.

Figure 11

Material examined. 6 juveniles, 1 male; to 2.8 mm.

Holotype: Qld, Great Barrier Reef, Lizard Island (14°40′S, 145°28′E), crest of patch reef in Lizard Island lagoon, coral rubble with algal turf, 2-3 m, B. Kensley, 11 Jan 1982 (stn BK-127), NMV J15034, juvenile, 2.8 mm (with 2 slides).

Paratypes: Type locality, QM colln, juvenile. Lizard Island, B. Kensley, Jan 1982 (stn BK-114), NMV J15035 (male). Lizard Is., Mrs Watsons Beach, dead coral rubble under bommie, 4 m, G.C.B. Poore, 11 Dec 1987 (stns NQ-118, NQ-120, NQ-121), NMV J14752-J14754 (3 juveniles). Qld, One Tree Island, (23°30′S, 152°05′E), One Tree Island lagoon, coarse sediment, 1.5 m, C. Short and J. Young, 17 Oct 1979 (AM Marine Ecology stn 2), AM P37928 (juvenile).

Diagnosis. Antenna 1 with 1 aesthetasc. Uropodal endopod 2.2 times as long as wide; exopod not reaching as far as endopod or telson, 3.3 times as long as wide, narrowly lanceolate. Telson basally narrow, 2.3 times as long as wide, lateral margins evenly convex, apex evenly rounded.

Male. Pereopod 1 propodus with 9 marginal setae, 1 very long. Telson and uropodal rami narrower than in juvenile.

Distribution. Queensland, Great Barrier Reef, coral lagoons.

Remarks. This species is most easily recognised by its very narrow uropodal exopod. Pereopods have very similar proportions to those of *K. biriwa;* their setation is identical. Pleopod 1 has 4 and 8 setae on the endopod and exopod respectively, fewer than in *K. biriwa.* The endopod is more rectangular.

Kupellonura werawera sp. nov.

Figure 12a

Material examined. Unique.

Holotype: Qld, Orpheus Island, Pioneer Bay (18°37′S, 146°29′E), coral rubble, 9 m, SCUBA, G.C.B. Poore and H.M. Lew Ton, 5 Dec 1982 (stn NQ-11), NMV J13036 (with 1 slide), juvenile, 3.1 mm.

Diagnosis. Antenna 1 with 1 aesthetasc. Uropodal endopod 2.1 times as long as wide, widest in distal half; exopod as long as endopod and telson, 1.8 times as long as wide, mesial margin straight proximally and oblique distally, lateral margin strongly lobed, widest as midpoint, concave over distal half. Telson basally narrow, 2.4 times as long as wide, parallel-sided over most of length, apex truncate with blunt terminal projection.

Distribution. Northern Queensland, Orpheus Island (known only from type locality).

Remarks. Kupellonura werawera is distinguished from other Australian species by the strongly lobed uropodal exopod and unusual telson. The telson of *K. werawera* resembles that of *K. mediterranea* Barnard (see Wägele, 1981a) but its uropodal endopod and exopod are much broader.

Pereopodal propodi are lightly narrower than in *K. biriwa* but the arrangement and number of setae is identical. The mouthparts are indistinguishable from those of *K. biriwa.* The first pleopod is also of a similar shape, the endopod and exopod having 5 and 10 setae respectively.

Kupellonura sp.

Figure 12b

Material examined. Tas., off east coast (42°37′S, 148°20′E), 102 m, epibenthic sled, R. Wilson, 9 Oct 1984 (stn CSIRO SO5/84/1), NMV J15054 (1 manca, 4.2 mm).

Remarks. This single manca from Bass Strait resembles *K. biriwa* from Western Port but differs sufficiently to probably belong to a separate species. The manca is larger than mancas of *K. biriwa,* has a much broader uropodal exopod and longer and narrower endopod. Its description awaits adult material.

Neohyssura Amar

Neohyssura Amar, 1953: 353.—Wägele, 1981a: 70, 71, 72, 75.—1981b: 72-73.

Horolanthura Menzies and Frankenberg, 1966: 41-42.—Wägele, 1981b: 82 (type species—*Horolanthura irpex* Menzies and Frankenberg, 1966).

Diagnosis. Antenna 1 flagellum of 4 articles, with 1 aesthetasc on the last article. Antenna 2 peduncle without stout plumose setae. Mandibular molar process an acute, fixed, finely denticulate spine; palp 3-articled. Maxillipedal endite short, broad; palp of 5 articles.

Pereopods 2 and 3 palm oblique with marginal spines. Pereopods 4-7 carpus triangular, carpus and propodus each with 1 posterodistal spine. Pleopodal rami both with several marginal setae. Uropo-

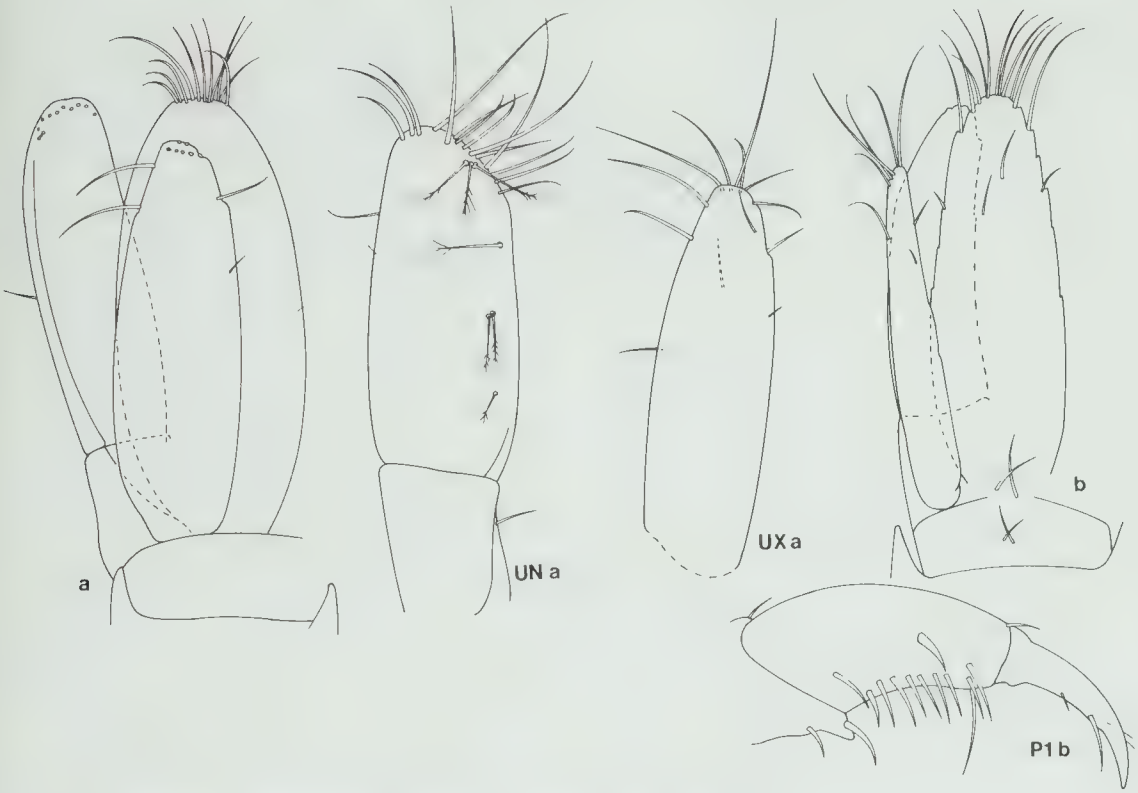

Figure 11. *Kupellonura marrongie*: a, holotype; b, paratype male, NMV J15035.

dal endopod free, longer than peduncle; exopod linear with cuticular spines on mesial margin. Telson as long as uropod, triangular, with cuticular spines on lateral margins.

Type species. Hyssura spinicauda Walker, 1901 (monotypy).

Remarks. Neohyssura is most similar to *Kupellonura* with which it shares undifferentiated pereopods, uropods, pleopods and mandibular and maxillipedal palps. The evenly tapering telson, and uropodal and telsonic spines are the apomorphies defining the genus. Negoescu and Wägele (1984) listed three species from the Atlantic Ocean, Indian Ocean and Mediterranean, and Wägele (1987) added a fourth from interstitial habitats in the Cape Verde Islands.

Neohyssura bilara sp. nov.

Figures 13, 14

Material examined. 2 juveniles, 1 female, 1 sub-male; to 4.2 mm.

Holotype: Qld, Shoalwater Bay, 140 m off Little Bank Beach, Triangular Island (22°30'S, 150°31'E), intertidal mudflat, J. Lewis, 13-16 Sep 1981, NMV J15037, gravid female, 4.2 mm (with 2 slides).

Paratypes: Type locality, QM colln, juvenile; NMV J15038, submale. Shoalwater Bay, Triangular Island, 50 m offshore, intertidal mudflat, J. Lewis, 3-6 Nov 1982, NMV J13039, juvenile.

Description. Head wider than long, rounded rostrum, without eyes. Antenna 1 peduncle, articles 1 and 2 with 1 and 3 fine brush-setae respectively; flagellum of 4 articles, last minute, with terminal aesthetasc. Antenna 2 flagellum of 8 articles.

Mandible with bluntly toothed incisor; lamina dentata coarsely toothed distally, finely toothed proximally; molar process a fixed, acute tooth, finely denticulate distally; palp of 3 articles, last with short terminal seta. Maxilla 1 inner lobe with 1 seta; outer lobe strongly curved, with 7 fixed teeth. Maxilliped with short broad endite bearing 1 seta; palp of 5 articles bearing 0, 1, 2, 2, 3 setae.

Pereopod 1 carpus produced as seta-bearing tooth; propodus triangular, palm oblique, with 2

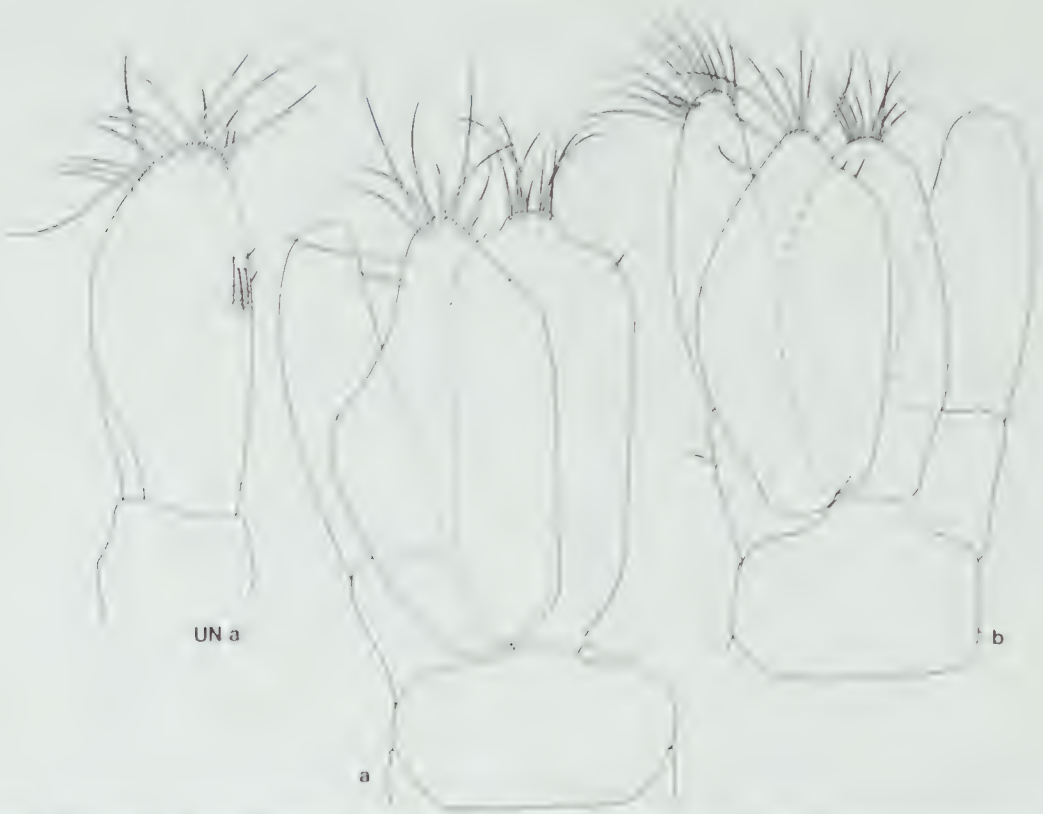

Figure 12. a, *Kupellonura werawera,* holotype. b, *Kupellonura* sp., manca, NMV J15054 (uropodal exopods drawn flat in situ).

mesial setae, 3 marginal setae and 2 submarginal setae distally. Pereopod 2 carpus strongly produced; propodus palm with 3 bifid spines with blade-like setae between. Pereopod 3 similar but smaller. Pereopods 4-7 carpus with posterodistal spine, propodus with porterodistal spine (plus accessory setae on pereopod 7).

Pleopods 1-5 peduncle with 2 mesial setae; endopod with 5 plumose setae; exopod smaller, with 9 plumose setae. Pleonal epimera 1-4 with 2-3 submarginal plumose setae, epimeron 5 with none. Uropodal endopod 3 times as long as peduncle, with 5 dorsal brush-setae, 5 marginal simple setae and 11 distoventral simple setae; exopod 4-5 times as long as wide, with 3 strong spines, posteroventrally directed along mesial margin, 4 marginal and 6 dorsal setae at apex. Telson widest proximally, 2.2 times a long as wide, triangular, with 3-4 spines on each side, 8 apical setae.

Submale. Antenna 1 flagellum of a long article without aesthetases and terminal article with 1 aesthetase as in juvenile. Pereopod 1 not differentiated. Appendix masculina longer than endopod.

Distribution. Central Queensland, bays.

Remarks. This new species is closest to *N. spinicauda* (Walker). Wägele (1981b) did not see a maxillipedal endite on this species but otherwise the species differs only in minor aspects of setation and proportions. The South African *N. skolops* Kensley is significantly different, especially in the tail fan and well-developed maxillipedal endite. Its endite, the toothed mandibular lamina dentata and molar process are more *Kupellonura*-like.

Xenanthura Barnard

Xenanthura Barnard, 1925: 138.—Wägele, 1981a: 69-75.—1981b: 84.

Diagnosis. Antenna 1 flagellum of 3 articles, with 1 aesthetase on last article. Antenna 2 peduncle with 1 or 2 stout plumose setae (in addition to typical brush-setae). Mandibular molar process an ar-

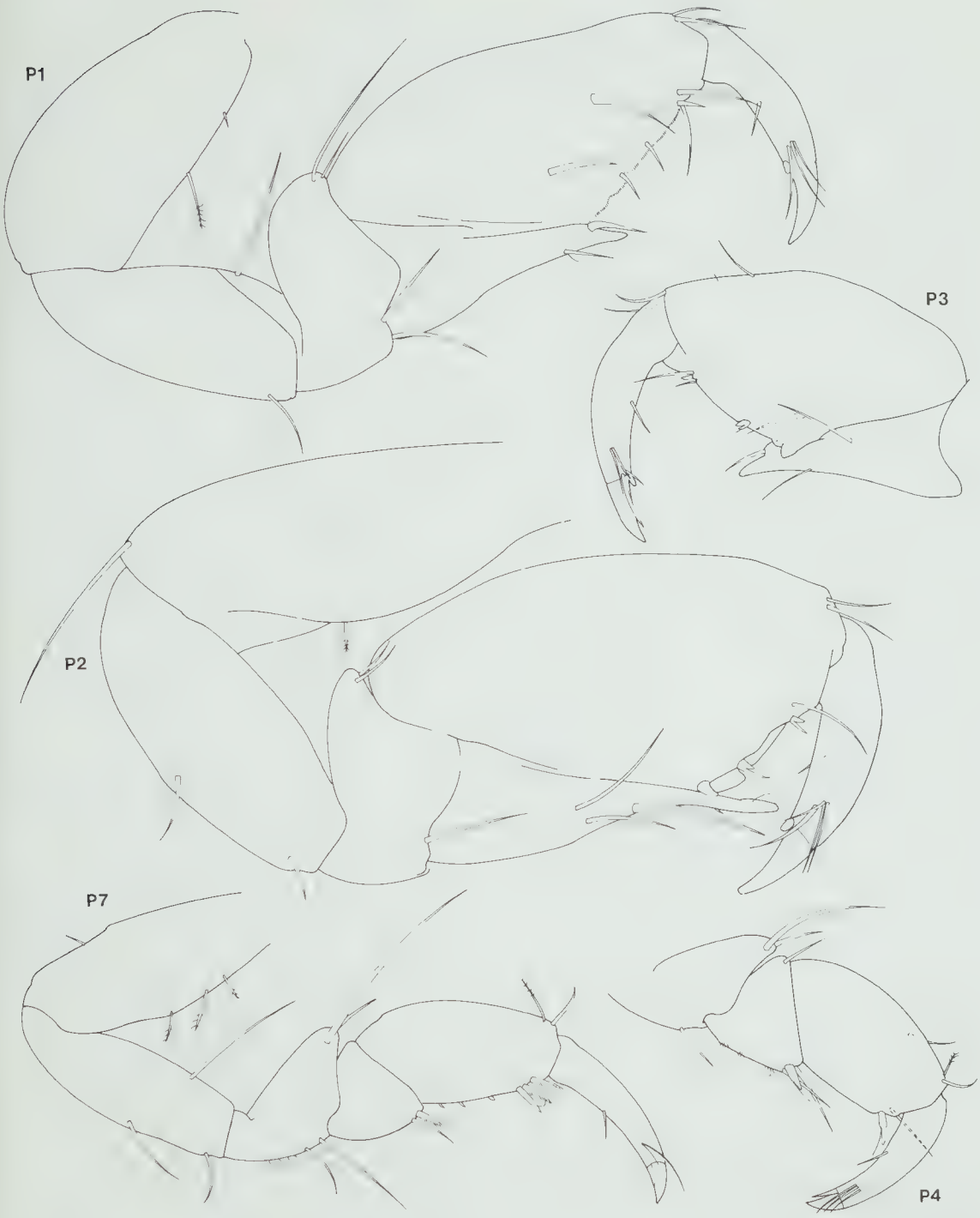

Figure 13. *Neohyssura bilara,* holotype.

Figure 14. *Neohyssura bilara,* holotype (uropodal exopod in ventral view).

ticulating spine; palp a single article with terminal setae. Maxillipedal endite short; palp of 5 fused or partially fused articles.

Pereopod 2 palm transverse, carpus strongly produced. Pereopod 3 broad distally, merus and carpus with long posterior setae. Pereopods 4-7 carpus triangular, without free anterior margin, without carpal and propodal spines. Pleopodal endopods triangular, with terminal seta; exopods ovoid, setose. Uropodal endopod fused to peduncle; exopod ovoid. Telson much shorter than uropods, tapering to excavate apex.

Type species. Xenanthura brevitelson Barnard, 1925 (monotypy).

Remarks. The presence of a molar spine, mandibular palp article and maxillipedal endite are noted for the first time for *Xenanthura.* These features were confirmed on the type species, *X. brevitelson* (material from Gulf of Mexico, NMV J11657). Similarities between this genus and *Belura* gen. nov. were noted earlier. George and Negoescu (1985) listed and mapped the distribution of the five species of *Xenanthura* then known (their species *X. acuticauda* is herein removed to *Belura* gen. nov). All are tropical or warm-temperate as is the new species described there.

Xenanthura ulawa sp. nov.

Figures 15–17

Material examined. 84 juveniles, to 5.2 mm; 1 female, 4.4 mm; 48 males, to 4.3 mm; 10 mancas.

Holotype: Qld, One Tree Island (23°30′S, 152°05′E), One Tree Island lagoon, "Shark Alley", 1.5 m, coarse sediment, C. Short and J. Young, 17 Oct 1979 (AM stn OT1 3.2), AM P29685, juvenile, 5.2 mm.

Paratypes: Type locality AM P29653 (4 juveniles), P29654 (1 male), P29655 (2 juveniles), P29656 (female in tube, male, manca), P29657 (2 juveniles), P29681 (1 manca), P29682 (1 juvenile, 2 males), P29684 (1 manca), P29686 (1 manca), P29689 (1 juvenile), P29690 (1 male), P29691 (1 manca), P29994 (1 juvenile), P30061 (1 manca), NMV J15040 (8 juveniles, 2 males).

Other material. Qld, bays and shelf off Townsville (19°16′S, 146°49′E), various collections: NMV J15041 (33 juveniles, 23 males), J15042 (1 manca, 1 male), J15043 (3 juveniles, 3 males), J15044 (1 juvenile, 1 male), J15045 (1 juvenile), AM P37927 (10 juveniles, 5 males), QM colln (10 juveniles), 5 males). Fantome Island (18°40′S, 146°31′E), NMV J15044 (1 male, 1 juvenile). Shoalwater Bay (22°30′S,150°31′E), J. Lewis, 1982, NMV J15057 (1 male).

NT. New Year Island (10°54′S, 133°02′E), 10-14 m, J.K. Lowry and G.C.B. Poore, 14 Oct 1982, NMV J15048 (1 juvenile), J15049 (1 juvenile) J15050 (1 manca). Oxley Island (11°00′S, 132°49′E), 14 m, muddy sand, J.K. Lowry, 21 Oct 1982, NTM colln (1 juvenile, 3 males). East Point, Fannie Bay (11°24′S, 130°48′E), 8-10 m, J.K. Lowry, 26 Oct 1982, NMV J15051 (1 juvenile).

WA. North-west Shelf, between Port Hedland and Dampier (18°41′S, 118°39′E), 134 m, G.C.B. Poore and H.M. Lew Ton, 4 Jun 1983 (stn NWA-21), NMV J15052 (1 juvenile); (19°38′S, 118°06′E), 49 m, 13 Jun 1983 (stn NWA-56), J15053 (1 juvenile).

Description. Body 20 times as long as wide, colourless. Head wider than long, truncate rostrum, dorsolateral eyes. Antenna 1 with fine brush-setae and stout tufted seta on article 2 of peduncle; flagellum of 3 articles, first with brush-seta, third with 1 aesthetasc, 2 plumose and 1 simple setae. Antenna 2 article 5 with fine brush-setae dorsally and stout tufted-setae ventrally; flagellum of 5 articles.

Mandible with blunt incisor; lamina dentata of 3 finely denticulate flattened plates; molar process an articulating spine with fine denticles along length; palp a single article with apical seta. Maxilla 1 inner ramus a broad lobe; outer ramus strongly curved, with 1 fixed spine, 3 articulating setae, plus 1 finer seta innermost. Maxilliped with short endite bearing 1 apical seta; palp a single plate with 3-4 mesial, 1 lateral and 3 distal setae.

Pereopod 1 carpus slightly produced posterodistally, with pectinate and stout setae on margin; propodus triangular; palm slightly oblique, with consistent pattern of pectinate and blade-like setae and stout setae, 4 mesial setae. Pereopod 2 carpus strongly produced to end of propodus, with 9 posterior and 2 anterior teeth; propodal palm oblique, with consistent pattern of 7 teeth and marginal setae. Pereopod 3 merus as broad as greatest length, posterior margin convex, with 11 triangular denticles and 9 long posterodistal setae; carpus posterodistally lobed, 1-2 cuticular denticles proximally, 20 long setae distally; propodus ovate, palm obscured; dactylus constricted near base. Pereopods 4-7 with few setae; merus, carpus and propodus with posterior marginal and submarginal digitiform denticles, dactylus with anterior and posterior denticles; propodus of pereopods 4-7 with 1, 2, 3, and 3 strong mesiodistal setae respectively. Pleopod 1 peduncle with 2 setae on narrow mesial lobe; both rami of 1 article; endopod triangular, with 1 distal seta; exopod narrow, with 12 plumose setae. Pleopods 2-5 similar to first. Pleonal epimera 1-4 with 2 marginal setae, epimeron 5 with none.

Uropodal peduncle and endopod fused, with broad ventromesial shelf bearing 4 large brush-setae in shallow distal concavity; apex rounded-acute, with 3 finer brush-setae, distolateral margin with 11 setae; exopods overlapping, 1.5 times as broad as long, 6 setae posteriorly. Telson widest proximally, apex about half basal width, concave, with 2 brush-setae near midpoint and short seta laterally.

Figure 15. *Xenanthura ulawa,* holotype (antennae in ventral view).

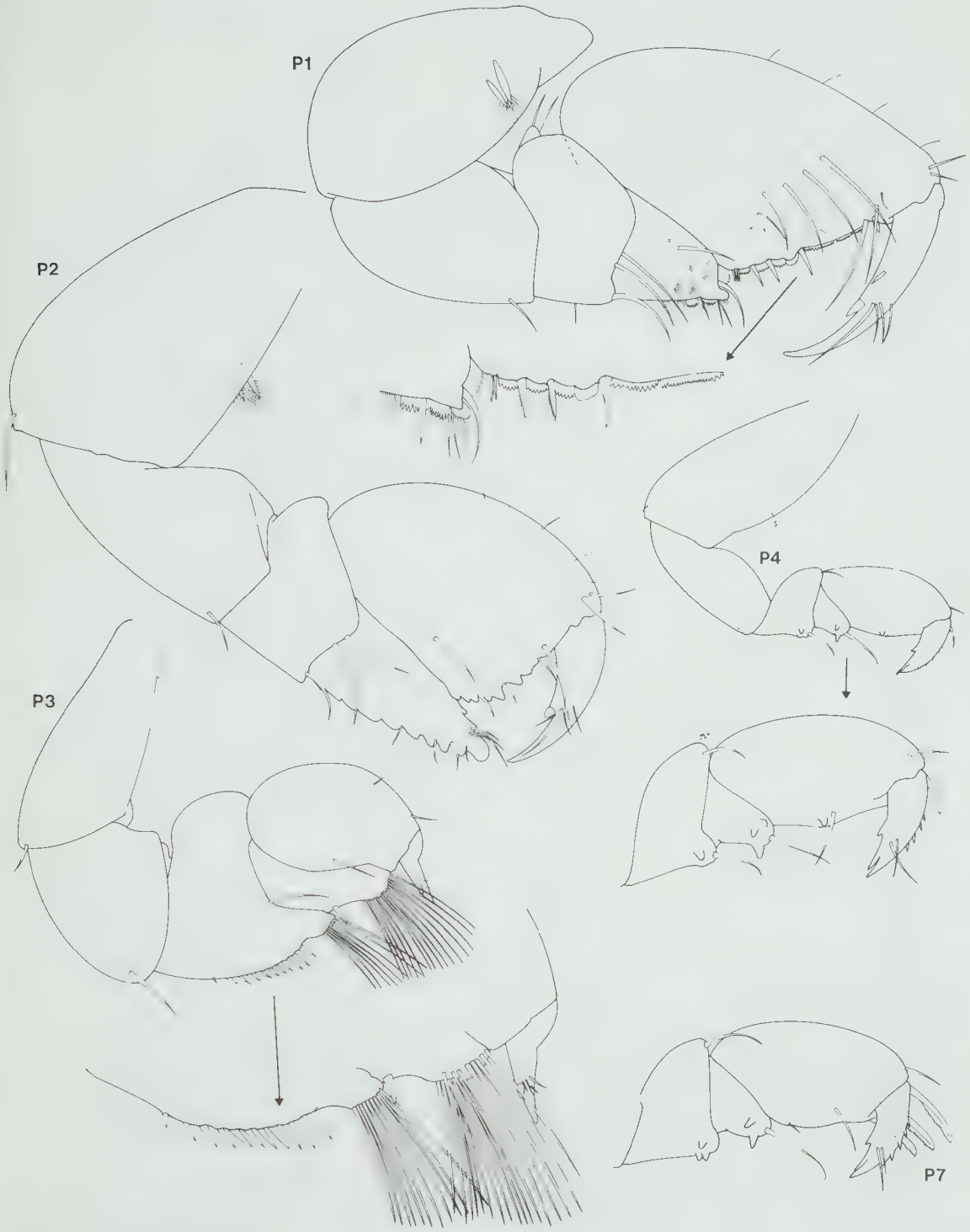

Figure 16. *Xenanthura ulawa,* holotype.

Figure 17. b, *Xenanthura ulawa*, paratype male, AM P29690. c, *Xenanthura brevitelson*, juvenile, Gulf of Mexico, NMV J11657.

Male. Head round, rostrum acute, lateral eyes tripartite. Antenna 1 flagellum of 10 articles: first short, articles 2-9 each bearing about 6 aesthetases, terminal article minute. Antenna 2 without tufted-seta.

Pereopod 1 similar to juvenile, with 13 mesial setae. Pereopods 2-7 same as in juvenile. Pleopod 1 peduncle more rectangular, exopod broader. Pleopod 2 with triangular endopod with 3 or 4 setae; broad curved appendix masculina, with 1 short and 1 longer articulating blunt spines apically; pleopods 2-5 exopods 2-articulate. Telson more elongate than in juvenile.

Distribution. Tropical north-eastern, northern and north-western Australia, shelf and lagoonal sediments.

Remarks. Xenanthura ulawa is recorded from a wide geographical area of tropical Australia and from both reef and shelf environments but showed little variability. The holotype differs from many other specimens in possessing one rather than two denticles on the carpus of pereopod 3.

The numbers of setae are constant between individuals and are useful to distinguish species. *Xenanthura ulawa* differs from *X. brevitelson* Barnard in having a broader telson (see fig. 17) with close lateral setae and more long setae on pereopod 3. The blade-like setae on the palm of pereopod 1 is replaced by a pectinate one in *X. brevitelson*. *X. sinaica* Wägele differs most obviously in pereopods 2 and 3, narrower telson and longer uropodal exopod. *X. bacescui* Negoescu has a triangular uropodal exopod and less tapered tel-

son. *X. orientalis* and *X. linearis* Pillai have a toothed carpus on pereopod 3.

A single female (gravid but without oostegites) was found in a thick mucilaginous tube.

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